



SCIENCE

JUNE 27, 1952

VOLUME 115

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Mellon Institute

RESearch PROCEEDINGS OF MELLON INSTITUTE, 1951-52, the annual report of the president, Edward R. Weidlein, to the board of trustees, describes the activities of the institute during the fiscal year ended February 29, 1952.

The institute is a nonprofit organization. During the year expenditures for pure and applied scientific investigation, all of which is long-range in scope, amounted to \$3,835,314. Of this sum \$727,654 was spent for supporting research programs in pure science on nine fellowships and in the departments of chemical physics, physical chemistry, physical measurements, instrumentation, and organic chemistry. Altogether 117 members of the institute were engaged in various pure science research projects. The applied science investigations have been conducted by 77 other fellowships employing 441 specialists and their aides. One of the fellowships is 40 years old; five are 35 years old; two, 30 years; nine, 20 years; sixteen, 15 years; and thirteen, 10 years. The institute's servicing staff numbers 162 supplemental members.

In 1951 there came from departments and fellowships of the institute 16 bulletins, 67 research papers, 65 other scientific articles, and 52 U. S. patents. *Air Repair*, *Industrial Hygiene Digest*, and *Nutritional Observatory* are periodicals edited by fellows. Traditionally, Mellon Institute is both a national and a local science center, being the meeting place of many professional societies. The observance of National Chemistry Week last September was climaxed for Pittsburgh people by a two-day open house at the institute, attended by 25,535 persons of the area.

Pure scientific research has been concerned with molecular and crystal structure of dicyanoacetylene, infrared spectra of inorganic salts, emulsion calibration procedures in emission spectroscopy, diffraction studies of reinforcing carbon blacks, and crystal structure of chlorine. Other noteworthy investigations have related to the biochemistry of mental diseases, cancer inhibition, air-pollution control, fate of industrial dusts following inhalation, chemical hygiene, new orthopedic devices, mine-acid control, distillation

theory, synthetic rubber properties, conservation of paintings, and digital computing machine components.

In applied science many fellowships have broad programs for the benefit of mankind through the professions and the industries. Seven new fellowships began operation: air purification, allotropy, automotive chemicals, clayworking, gaseous combustion, glass properties, and yeast chemistry. Seven others will begin as soon as personnel and facilities are available. Twelve programs were concluded during the year. The fellowships on refractories, bentones, and soybean technology initiated new long-term projects. The optical glass, bone products, and agglomeration fellowships were broadened in scope. The acid-recovery fellowship evolved a promising process for treating waste pickle liquor with coke-oven gas. Marked progress was made with meter technology, heat insulation, metalworking, abrasive wheel grinding, arc welding, chemical storage, steel protection, coal-waste control, and basic coal-chemical technology; and success was attained in the reverse drawing of steel. A new series of polyfunctional monomers was synthesized, and a large number of derivatives of alkylated phenols have been studied in coal-chemical research. Notable advancement has been achieved in contriving methods for petroleum sulfur-compound analysis. Projects on catalysis in petroleum technology have been fruitful, and eleven papers came from those studies. Pyrenone grain protectant, a creation of the insecticide fellowship, has been put to effective practical use. New dextrose derivatives came from researches on corn products. A cluster of fellowships was quite productive in the field of textiles, and novel and efficient cold-climate insulation fillers and modified chicken-feather preparations for sleeping bags were devised. Extension of the manifold applications of vinyl resin dispersions through plastigels that have important industrial significance increased versatility of the silicones, and the development of two new floor coverings are some of the other results of the institute's varied 1951 program.

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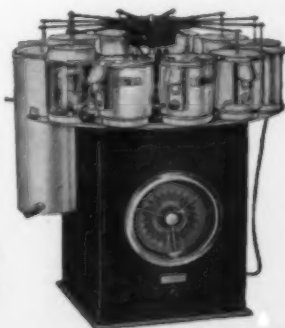
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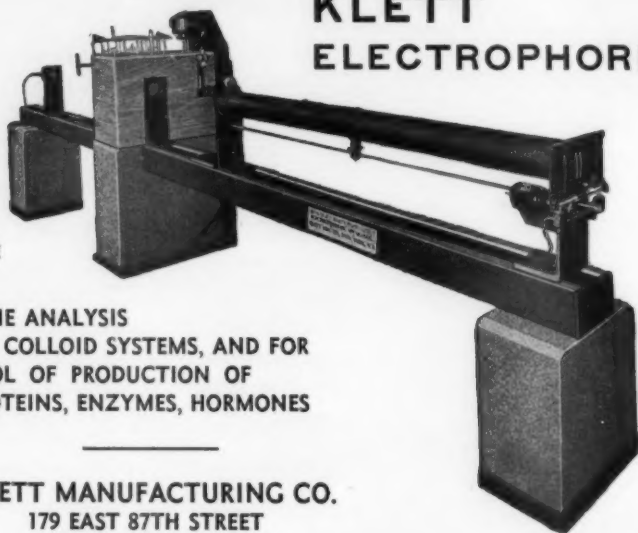
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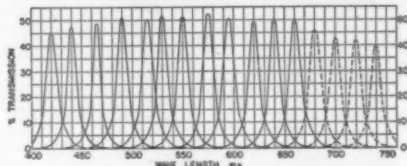
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Nucleic Acid and Protein Conference

Kurt G. Stern and Max A. Lauffer

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and Department of Biophysics,¹ The University of Pittsburgh*

THE second Gordon Research Conference on "Nucleic Acids and Proteins" was held at New Hampton, New Hampshire, August 27-31, 1951.² Among the eighty-one scientists participating in the conference, twenty-three came from countries outside the United States—namely, England (11), Canada (5), Sweden (3), Denmark, Holland, Italy, and Israel. The international character of the meeting was, in large measure, due to the continued support of the Rockefeller Foundation.

The main topics under discussion dealt with nucleic acid structure, physical studies on viruses and virus metabolism, effect of ionizing radiations on biological systems, and protein studies. Twenty-two papers were presented at nine sessions.

The first two sessions were devoted to a symposium on the structure of nucleic acids and certain nucleotides. Erwin Chargaff (Columbia University), Maurice Stacey (University of Birmingham), Gerhard Schmidt (Boston Dispensary), Waldo Cohn (Oak Ridge National Laboratory), and Hubert S. Loring (Stanford University) discussed the subject from various points of view. Dr. Chargaff first reviewed previous work of his laboratory on the structure of desoxypentose nucleic acids, which had led to the conclusion not only that the compositions of these compounds deviate in most cases very considerably from that postulated by the classical tetranucleotide hypothesis, but also that they differ from each other in a manner characteristic for the species (but not the tissue) from which they have been isolated. On the other hand, certain remarkable regularities in the relative proportions of the nitrogenous constituents were observed. Thus, all desoxypentose nucleic acids so far examined possess a purine-to-pyrimidine ratio of unity, and the same holds for the ratio of guanine to cytosine. The AT-type contains adenine and thymine, whereas the GC-type contains guanine and cytosine as major components. It was found that all the purines can be removed, yielding polymers composed of pyrimidine nucleotides ("apurinic acids"). In the instance of pentose nucleic acids (PNA), a branched structure with a polyguanylic acid chain as the backbone was considered. In the subsequent discussion, R. G. Wyatt confirmed Chargaff's general conclusions on the basis of his own analyses. He found that desoxypentose

nucleic acids (DNA) from various animal tissues contain a small amount of 5-methyleytosine, the amount being characteristic of the species serving as the source. In contrast, the DNAs of several insect viruses were found to be free of methyleytosine.

The nature of the linkages present in desoxypentose nucleic acids was discussed by M. Stacey, who pointed out that polynucleotide chains may be either straight or branched. They may be ruptured by various means, including ultrasonic waves and ion exchange resins. Upon chain rupture, RCHO-groups are set free, resulting in a positive Feulgen reaction, and the release of purine residues may be followed by the Dische reaction. Steric effects may arise from interaction between base (purine, pyrimidine) groups, leading to a partial stripping of the side branches from the main chain. The possibility of cross-linking by amino and enolic hydroxyl groups was considered. In the discussion, Chargaff pointed out that nucleic acids may also be considered as a form of polysaccharide. DNA, in contrast to PNA, does not appear to be highly branched, and it is possible that links other than phosphoric acid ester bonds are involved in the polymer DNA-structure. Stacey mentioned that D. O. Jordan's work indicates some degree of branching in DNA.

The enzymatic hydrolysis of ribonucleic acids, with particular reference to its bearing on the concepts of their structure, was discussed by G. Schmidt, who employed prostate phosphatase, an enzyme of high activity toward PNA. The hypothesis that PNA consists of a purine polynucleotide and a pyrimidine polynucleotide, which are linked together only at one point, was considered untenable on the basis of the results obtained by the enzymatic hydrolysis of PNA by ribonuclease and phosphatase. The action of ribonuclease leads to the conclusion that the core of PNA consists largely of purine nucleotides. PNA represents a highly branched structure, from which the ribonuclease removes terminal pyrimidine nucleotide residues.

Studies on the structure of various nucleotides isolated from nucleic acids were described by W. Cohn and H. S. Loring. Dr. Cohn reported the discovery of new nucleotides from previously known nucleic acids from the work of his group on ion exchange adsorption columns. In addition to the separation of isomeric forms of adenylic, guanylic, cytidylic, and uridylic acids from yeast PNA, a fifth desoxypentose

¹ Publication No. 8 of the Department of Biophysics.

² For a report on the first Nucleic Acid and Protein Conference see E. R. Blout and P. M. Doty, *Science*, **112**, 639 (1950).

nucleotide (5-methylcytosine) was isolated from DNA. The new ribose compounds consist of two sets of isomers of the well-known 3'-nucleotides, one set being esterified at the 5'-position and arising from enzymatic hydrolysis, the other set being derived by chemical hydrolysis of PNA. In addition, diphosphates of cytidylic and uridylic acids have been isolated from enzymatic digests. The nearly quantitative yields of 5'-nucleotides from such systems support Gulland's earlier postulate that this linkage is of major importance in intact PNA.

Dr. Loring described improved methods for the isolation of pure cytidylic acid isomers from alkaline yeast PNA-hydrolysates, involving the use of ion exchange resin (Dowex 2) columns or the selective precipitation of the isomer of lower optical activity in the form of a crystalline monoammonium salt. From their chemical behavior it was concluded that the isomerism involves the location of the phosphate grouping rather than an α , β -isomerism of the ribose residues. The comparison of the two compounds indicates that the isomer of lower optical activity ($[\alpha]_D = -8^\circ$) represents the 2'-phosphate ester, whereas that of higher activity ($[\alpha]_D = +46^\circ$) is the 3'-ester. In the discussion, K. Linderström-Lang (Carlsberg Laboratories, Copenhagen) stated that the splitting of PNA by ribonuclease is accompanied by a marked volume contraction, which is indicative of the formation of charged groups, such as amino groups.

Stig Claesson (University of Upsala) discussed recent advances in adsorption analysis, with particular reference to the optical methods developed by Arne Tiselius and himself for the study of "flowing chromatograms." He discussed the method of carrier displacement analysis and the use of interferometry, polarography, and radioisotopes in the study of the separation of complex systems; e.g., protein and fatty acid mixtures. In certain phases of this work—e.g., in the separation of polymers by fractional extraction according to Desreux—automatic arrangements consisting of packed columns, syphon systems capable of removing samples with an accuracy of 0.5 per cent, and a series of collecting tubes mounted on revolving turntables were employed with satisfactory results.

The following two sessions were utilized for the discussion of work involving protein systems of different types. Dr. Linderström-Lang spoke on the volume changes taking place during proteolysis. When peptide bonds are broken at pH 6-7 by the action of enzymes, two ions appear, a carboxylate and a substituted ammonium ion. The compression of the water dipoles surrounding these ions results in a considerable volume decrease (Δv), which may be determined accurately by dilatometric methods. Experiments with simple amino acids and peptides have shown that this "electrostriction" effect reaches a maximum when a peptide bond near the center of a long peptide chain is split ($\Delta v = -20$ ml/mole peptide bond). In the case of many globular proteins, however, the much larger Δv values that have been observed (over -100) are explained by assuming that

the collapse of the protein molecule caused by the instability resulting from the enzyme action is accompanied by a volume decrease, which is additive to the direct electrostriction effect.

It is unlikely that the breaking of salt-linkages is responsible for this extra volume decrease. The phenomena observed may be tentatively interpreted in terms of Linus Pauling's recent theory of protein structure (*Proc. Natl. Acad. Sci. U. S.*, **37**, 205, 235, 241, 251, 256, 261, 272, 282 [1951]) employing the postulate of helical configurations. Such a structure might allow for two different types of protein denaturation; namely, a reversible type involving the stretching of the helices in the direction of their long axis and an irreversible type consisting in the separation of helices.

Albert Wassermann (University College, London) discussed the influence of cation exchange on properties of muscle proteins on the basis of joint experiments with M. L. R. Harkness. Myosin, as extracted from muscle with salt solutions at 0° C, will adsorb a considerably smaller number of inorganic cations than would correspond to the side chain carboxyl groups of the protein preparations. However, when rabbit muscle is cooled to -79° C prior to mincing, "K⁺-protein" gels are obtained in which the side chain carboxyl groups are largely neutralized by potassium counter ions. Conversion into the potassium-free "H⁺-protein" form may be accomplished by treatment with the hydrogen form of a commercial cation exchange resin (Amberlite). This stoichiometrically well-defined, reversible potassium-hydrogen ion exchange is accompanied by a marked, reversible decrease of the viscosity and flow birefringence of the myosin gel. The effect can be explained by a change of the molecular shape of the main valency chains to which the side chain carboxyl groupings are attached.

Recent experiments on the mechanism of reaction of hemoglobin with oxygen and carbon monoxide were discussed by F. J. W. Roughton (Cambridge University), with special reference to the problem of protein individuality. According to the intermediate compound hypothesis of Adair, the hemoglobin molecule combines with oxygen (or carbon monoxide) in four successive stages. The resultant equation contains four equilibrium constants corresponding to the four successive reactions postulated. Recent improvements in technical accuracy, together with the introduction of new mathematical methods of analyzing the results, now make it possible to determine the numerical values of the four constants with fair accuracy. The new data, obtained on ram hemoglobin, indicate that the combination of the first three oxygen molecules facilitates greatly the combination of the fourth molecule with hemoglobin, probably in consequence of a steric effect.

The structure of hemoglobin and myoglobin was discussed by J. C. Kendrew, also of Cambridge. His approach was chiefly based on x-ray diffraction studies carried out in collaboration with Perutz and Bragg. The Patterson projections of the diffraction

patterns of several crystalline proteins (two species of hemoglobin and of myoglobin, ribonuclease) indicate rodlike structures that may be interpreted as the vector transforms of more or less parallel, straight polypeptide chains, about 10 Å apart, often in close hexagonal packing. All conclusions going beyond this point must be regarded as tentative. In the case of horse hemoglobin, Perutz' views have lately undergone some modifications. The stepwise shrinkage of the crystals is now attributed to the jerky movements of irregularly shaped molecules past one another, rather than to the withdrawal of successive layers of water molecules from ordered liquid layers in the crystal.

With regard to the helical configuration of the α -chain proposed by Pauling and Corey, the recent discovery by Perutz of 1.5 Å reflections from synthetic polyamino acids and from α -keratin and muscle lends strong support to the suggestion that these materials are built up essentially of such chains. In globular proteins the situation is still very confused since, although Perutz had obtained a faint 1.5 Å reflection from hemoglobin, an examination by Carlisle of his very complete three-dimensional data for ribonuclease has failed to reveal any such reflection. There exist grave objections to the hypothesis that hemoglobin or similar proteins are made up of any simple arrangement of chains of the configurations proposed by Pauling or by any other workers: When the Patterson projections are put on an absolute scale, the heights of the peaks attributed to polypeptide chains are found to be very much smaller than those calculated. The structure of hemoglobin seems to be more complicated than has heretofore been supposed. More three-dimensional data are needed, but once they are available it is not unreasonable to hope that the analytical methods now available will yield unequivocal results. Kendrew pointed out that Pauling's helical chains are very rigid. Any distortion would lead to the breakage of hydrogen bonds. The chains might be short, however, and sharp turns may occur only at the proline links.

David Harker (Polytechnic Institute of Brooklyn) discussed the interpretation of x-ray data obtained on proteins. Instead of individual atoms, one might consider groups of atoms ("globs") as scattering units. Projections perpendicular to those of Bragg and Perutz have been studied. One of the difficulties is that Patterson diagrams yield distances and intensities, whereas an elucidation of the molecular structure requires a knowledge of atomic positions and amplitudes. Dr. Harker has recently found that, in certain instances, intensities can be converted directly into amplitudes.

One of the outstanding contributions to the conference was a paper by F. Sanger (Cambridge University) on the structure of insulin. His experiments, carried out with H. Tuppy, led to the elucidation of the amino acid sequence in the phenylalanyl chain of insulin. Fraction B, which was derived from this chain by oxidation, was subjected to partial hydrolysis with acid and alkali, and the resulting mixture of peptides

was fractionated by paper chromatography. From the structure of these small peptide fragments five amino acid sequences were deduced as being present in insulin, but it was not possible to work out the whole sequence. Hydrolysates were obtained by the action of proteolytic enzymes, and from the peptides identified by various methods (paper chromatography, adsorption of aromatic amino acids on charcoal and of peptides of cysteine acid on basic ion exchange resins) the following structure of the phenylalanyl chain was established: Phenylalanine-valine-aspartic acid-glutamic acid-histidine-leucine-cystine-glycine-serine-histidine-leucine-valine-glutamic acid-alanine-leucine-tyrosine-leucine-valine-cystine-glycine-glutamic acid-arginine - glycine-phenylalanine-phenylalanine-tyrosine-threonine-proline-lysine-alanine. Fraction A, which possesses a terminal glycine group, is joined to Fraction B by disulfide bridges of cysteine residues. The results obtained agree with a molecular weight value of 6000 for insulin obtained by other methods. The construction of a helical chain model of insulin of the type postulated by Pauling shows that the amino acid side chains project from the peptide backbone without steric hindrance.

An important section of the conference was devoted to a symposium on virus metabolism. F. W. Putnam (University of Chicago), S. J. Singer (California Institute of Technology), C. G. Hedén (Caroline Institute, Stockholm), and L. W. Labaw (National Institutes of Health, Bethesda) presented papers dealing with the formation of nucleic acid in bacteriophages of the T system as they multiply in *Escherichia coli* organisms. Tracer studies provided most of the information.

Investigations of the origin of bacteriophage nitrogen, carbon, and phosphorus, with emphasis on bacterial precursors, were described by Dr. Putnam. *E. coli* cells were labeled by growth in synthetic lactate media containing N^{15} , P^{32} , and carboxyl C^{14} lysine, or by growth in a medium containing C^{14} purines. They were then infected with T6^r or T7 bacteriophages. It was found that host nitrogen, phosphorus, and purines were used independently for synthesis of virus nucleoproteins. Host purine and host lysine were incorporated intact into virus protein. Preformed bacterial acid-soluble components were excluded as a major source of virus nucleic acid phosphorus.

In the case of T6 bacteriophage, only 20-30% of the phosphorus and nitrogen originates in preformed constituents of the host. However, multiple infection of N^{15} - and P^{32} -labeled cells with T7 bacteriophage revealed that most of the nitrogen and phosphorus of T7 is derived from the bacteria. These observations were interpreted in terms of synthesis of bacteriophage nucleic acid from a pool of virus precursors derived initially in large part by degradation of host desoxyribonucleic acid, and subsequently from precursors synthesized after the assimilation of phosphorus from the growth medium.

Dr. Labaw described recent experiments in which

radioactive phosphorus was used to study the phosphorus uptake of bacteriophages of the T system. His studies were interpreted to indicate that all the bacteriophages obtained substantially the same absolute amount of phosphorus per infectious unit from the host, *E. coli*. The phosphorus is derived for most bacteriophages from end products of the phosphorus anabolism, but at least in one instance it is derived from phosphorus in transit. Labaw concluded that there seems to be a similar unit of desoxypentose nucleic acid in all the *E. coli* bacteriophages.

Dr. Hedén discussed the possibilities of obtaining information about the preconditions for phage multiplication by studying the metabolism of the host cells under different physiological conditions. He stressed particularly that the cell in the lag phase should be studied, because in a very short period of time the cell changes from a poor to a good substrate for virus production. In the case of *E. coli* infected with T2r⁺ bacteriophage, the yield of phage calculated both per cell and per unit of volume was greater in the later lag phase than in the earlier lag phase. However, the latent period for phage multiplication was constant. As a result of studies involving both ultraviolet absorption and tracer data, Hedén concluded that phage nucleic acid is synthesized much more rapidly than bacterial desoxyribonucleic acid in the lag phase cell, especially at low bacterial densities.

Dr. Singer described experiments in which T2r⁺ bacteriophage desoxyribonucleic acid was released by grinding the bacteriophage particles in neutral 0.1 ionic strength buffer in a colloid mill. The nucleic acid released was purified by centrifugation. It was shown to have an extrapolated sedimentation constant of 13.1 Svedbergs, a value quite similar to that obtained for thymus desoxyribonucleic acid. Singer also described preliminary electrophoresis and ultracentrifuge studies of high molecular weight components of normal *E. coli* cells and of T2r⁺ bacteriophage infected cells. Several components were found in each case. In infected bacteria, desoxyribonucleic acid was attached to components of low electrophoretic mobility. These Singer regards as possibly being nucleoproteins that are related to the bacteriophage particles ultimately produced. In the discussion, H. K. Schachman (University of California) presented somewhat similar findings relative to degradation products of bacterial cells.

Singer also presented studies on cytoplasmic constituents of normal plant tissue. A constituent, probably nucleoprotein in nature, composing from one third to one half the total cytoplasmic protein, was obtained. This material was apparently homogeneous by the criteria of ultracentrifugation and electrophoresis. The sedimentation constant was found to be 18 Svedbergs; a molecular weight of about 600,000 was reported.

In the discussion, Max A. Lauffer (University of Pittsburgh) pointed out that the findings of Stanley, Knight, and others, that different strains of tobacco mosaic virus are associated with proteins of distinct

but different amino acid composition regardless of the host, exclude the possibility that high molecular weight constituents found in high concentration could be incorporated per se in virus synthesis. Barry Commoner (Washington University, St. Louis) described electrophoresis studies on plant tissue extracts obtained from both healthy tobacco plants and tobacco plants infected with tobacco mosaic virus. Commoner presented evidence that virus synthesis does not take place at the expense of the major normal constituent; on the contrary, tobacco mosaic virus formation is associated with a general stimulation of the synthesis of other proteins.

At a session devoted to physical studies on viruses Lauffer considered the problem of hydration of virus characteristic particles. Estimates of the hydrodynamic volume of particles of any shape can be obtained from the limiting volume of pellets centrifuged from suspension and from the backward displacement of an indicator substance in an ultracentrifuge experiment.

In principle, hydration can also be evaluated from knowledge of the partial specific volume and the density of the hydrodynamic unit in solution, as determined by sedimenting the material in media of different densities. In spite of the limitations of the various methods, all yield values of hydration of virus-characteristic particles in the range of 50-80% by volume on a wet basis for tomato bushy stunt, Southern bean mosaic, influenza, and rabbit papilloma virus particles.

Schachman showed what happens to tobacco mosaic virus nucleoprotein particles when they are broken down in alkaline media. Ultracentrifuge experiments carried out in collaboration with W. F. Harrington showed that at pH 10 the virus protein particles, which have a sedimentation rate of around 190 Svedbergs, are transformed into particles with much lower sedimentation rates. One fragment with a sedimentation rate of 4 Svedbergs accumulated more rapidly at 0° than at 25° C because it aggregates into a material with a sedimentation constant of about 50 Svedbergs, and aggregation takes place more rapidly at 25° C than at 0° C. The significance of this observation is the demonstration that medium-sized particles obtained as a result of disintegration of virus protein particles are not necessarily fragments of the original material. This renders invalid many of the attempts that have been made to deduce the structure of virus protein molecules from degradation studies.

M. F. H. Wilkins (Kings College, University of London) showed how studies with polarized light could be used to elucidate the nature of the inclusion bodies frequently found in cells of plants diseased with tobacco mosaic virus. The inclusion bodies are generally considered to be composed of the virus nucleoprotein. Wilkins observed a grating effect or a Bragg reflection effect indicative of a uniform spacing in these inclusion bodies of around 4000 Å. From other studies the characteristic nucleoprotein particles of tobacco mosaic virus are known to be

rodlike bodies about 3000 Å in length. Thus, the 4000-Å spacing observed by Wilkins might be related in some way to the lengths of the individual virus protein particles in the crystalline inclusion body.

The final subject considered at the conference was the effect of ionizing radiations on nucleic acids, proteins, and other molecules of biological interest. J. Weiss (University of Durham, England) described the chemical effects on some simple molecules and on nucleic acid. Large doses of x-radiation were applied to chemical substances in aqueous solutions. Conditions were such that the effect observed could be expected to be due largely to monovalent hydrogen and hydroxyl radicals formed by the absorption of radiation by water. It was shown that benzene, when treated with x-rays and γ-rays, is converted into phenol and some diphenyl. Doses of x-rays of the order of a million roentgens applied to nucleic acid led to the formation of ammonia, to an increase in van Slyke nitrogen, to an increase in titratable acid groups, and to the liberation of phosphate and of free adenine and guanine. When amino acids were irradiated, it was found that ammonia, carbon dioxide, acid aldehyde, and acetic acid would be recovered. In acetic acid solutions, cholesterol is converted quantitatively into triol.

J. A. V. Butler (Chester Beatty Research Institute, Royal Cancer Hospital, London) described experiments on the action of x-rays and some radiomimetic chemicals on desoxyribosenucleic acid. The x-ray doses used in Butler's experiments were considerably lower than those described by Weiss, and the effects on the nucleic acid were essentially physical. Prior to treatment, desoxyribosenucleic acid solutions are highly viscous and give strongly skewed diffusion curves. Irradiation and treatment with such radiomimetic chemicals as nitrogen mustards resulted in decrease in viscosity, decrease in the skewness of diffusion curves, and alteration in the slope of the electrophoretic mobility curves. These changes were interpreted in terms of the breaking of hydrogen bonds and the consequent decrease in the stiffness of the molecules.

Virgil L. Koenig (Los Alamos Scientific Laboratory) described experiments on the physicochemical changes in bovine fibrinogen which result from irradi-

ation with 45 kv x-rays. The fibrinogen was irradiated in the dry state and also dissolved in 0.1 M NaCl and in 0.1 M disodium phosphate solutions. Changes in the sedimentation rate of the protein at various concentrations and in the viscosity of the protein solutions resulted. The fibrinogen was also irradiated in the presence of oxygen, nitrogen, and helium. The oxygen and nitrogen did not change appreciably the effect produced, but the helium increased it, presumably because of high-energy absorption by helium. Very large doses of radiation resulted in the formation of a heavier second component in the ultracentrifuge diagram. In the dissolved state, about 50,000 roentgens will produce an observable effect, but in the dry state at least a million are required.

Ernest Pollard, of Yale University, described research being carried out in the Biophysics Laboratory of that institution on the action of primary ionization on enzymes and viruses. Dry specimens of trypsin, pepsin, T1 bacteriophage, and other biologically active proteins were bombarded with deuterons and electrons. In general, the loss of biological activity decreased exponentially with the dose of irradiation. This result is consistent with the target theory of the action of ionizing radiation and permits the evaluation of a target cross section or a target volume. In general, the target sizes obtained in this manner for the biologically active unit agree well with the sizes of the protein molecules or characteristic particle associated with the active substance. This fact indicates that a single ionization anywhere within a structure is sufficient to lead to loss of biological activity. The results also provide additional evidence for the identity of the particles causing the biological effect—that is, the enzyme activity or the virus infectiousness, with the protein molecule or the virus characteristic particle.

R. W. G. Wyckoff was chairman and Kurt G. Stern was vice chairman of the conference. It was decided to hold the next Gordon Nucleic Acid and Protein Conference in 1953, with Stern as chairman and M. L. Anson vice chairman. The program committee includes, in addition to these officers, K. Linderström-Lang, R. W. G. Wyckoff, Waldo Cohn, John L. Oncley, Gerhard Schmidt, and Seymour J. Singer.



News and Notes

Symposia in Neurophysiology

THE SPINAL CORD was the subject of a conference under the auspices of the Ciba Foundation at its house at 41, Portland Place, London, Feb. 26-28. Under the chairmanship of E. D. Adrian, president of the Royal Society, and the vice-chairmanship of G. L. Brown, some 44 persons, 18 of them from overseas, attended by invitation.

The five sessions were planned to encourage reports of stimulative and frontier character, the airing of differences in interpretation, and free discussion. Most of the overseas members stayed at the foundation, and this, together with intermissions, luncheons, a reception, and a dinner on the premises, was conducive to informal exchange of ideas. All arrangements were made by G. E. W. Wolstenholme, executive secretary, and his staff, out of the experience of a series of similar conferences over the past three years. The 20 papers read began with comparative physiology of synaptic transmission by T. H. Bullock, of Los Angeles, and ended with clinical experiments in poliomyelitis by D. M. Brooks, of London, and they ranged through development, architecture, reflexology, analysis of potentials, and pharmacology.

D. H. Barron, of New Haven, interpreted new experiments as meaning that embryological dendrite growth of motoneurons is dependent on the prior event of axons reaching an appropriate muscle, though dendrite pattern depends on the position of the cell in the cord rather than destination of the axon. G. J. Romanes, of Edinburgh, described the groupings of motor cells in the cord in a wide variety of vertebrates with differently developed limb musculature and use, from frogs to whales. The evidence poses the question, without suggesting an answer: What accounts for, or correlates with, these patterns of motoneuron grouping? C. G. Bernhard, of Stockholm, C. McC. Brooks, of New York, F. Bremer, of Brussels, and J. L. Malcolm, of London, each reported on analyses of the potentials recorded from the cord or its roots.

C. B. B. Downman, of London, compared the motoneuron discharges, their distribution, and properties as elicited by stimulation of splanchnic and of intercostal nerves. W. Schlapp and A. A. Jefferson, of Manchester, discussed long and labile depression following repetitive stimulation of muscle afferents. J. C. Eccles, of Canberra, presented evidence from antidromic excitation of motoneurons with intracellular recording, which he interpreted as showing block at the distal end of the unmyelinated segment of the axon and at the origin of the axon. Yves Laporte, of Toulouse, announced the discovery of three neuron pathways so linked as to countermand the myotatic reflex and mediate the lengthening reaction. R. Lorente de N6, of New York, reviewed synaptic transmission properties of oculomotor nuclei.

C. R. Skoglund, of Stockholm, opened a series of pharmacological papers with his results on close intra-arterial injection of the anticholinesterase "tabun" on cord responses, showing apparent selective action on different components of the cord. D. W. Kennard, of London, also applied drugs, but by a method of direct injection with micropipettes inserted in the cord; and W. S. Feldberg, J. A. B. Gray, and W. L. M. Perry, of London, used another close arterial injection route. D. Taverner, of Leeds, contrasted the effects on the monosynaptic and polysynaptic responses of intravenous *d*-tubocurarine and strychnine in variously prepared cats. P. A. Merton, of London, suggested how the proprioceptive control of muscle effort looks to a servo-control engineer. K. E. Hagbarth, of Stockholm, corrected frequent oversimplified accounts by showing that ipsilateral skin stimulation can evoke both flexion and extension, with reciprocal inhibition according to the area of skin and the balance between excitation and inhibition. The lateral cervical nucleus, studied by G. Ström and B. Rexed, of Stockholm, seems to relay from the skin of the ipsilateral forelimb to cerebellar cortex.

Other members of the conference participating in the discussion included H. J. Bein (Basel); Edith Bülbring, J. H. Burn, E. G. T. Liddell, and C. G. Phillips (Oxford); Rosamond M. Eccles (Canberra), A. Fessard (Paris); A. Gallego (Madrid); H. Hermann (Lyon); R. Jung (Freiburg); B. Katz, A. Schweitzer, G. P. Wright, and J. Z. Young (London); B. H. C. Matthews and W. A. H. Rushton (Cambridge); T. Roberts (Glasgow); D. Whitteridge (Edinburgh); and O. Wyss (Zurich).

Interest ran particularly high with reference to the recent announcement of J. C. Eccles of his abandonment of the so-called Golgi cell hypothesis of inhibition, put forward in 1947 jointly with C. McC. Brooks, and of his conversion to the hypothesis of chemical transmission in the central nervous system. These changes were prompted primarily by the finding, with an intracellular electrode in a motoneuron of the ventral horn, of a 3-mv potential having the shape and time course of familiar excitatory postsynaptic potentials but of opposite sign, upon arrival of an inhibitory presynaptic volley. This hyperpolarization he believes unaccountable by local circuit effects from presynaptic potentials and therefore necessarily due to chemical transmission, which also becomes most likely for excitation. This view was welcomed by Henry Dale, W. S. Feldberg, and others, and was opposed among others by Brooks and de N6. Discussion was lively, friendly, and informative.

The conference took place immediately following two other events, to which members were also invited. A two-day meeting of the Physiological Society at the new laboratory of the National Institute for Medical Research, Mill Hill, London, included many papers and demonstrations in neurophysiology. At the

Royal Society in Burlington House a symposium on Excitation and Inhibition was held Feb. 21, with Professor Adrian in the chair. Papers were contributed by A. L. Hodgkin, Katz, Fessard, de Nô, R. Granit, Feldberg, and Eccles, with a brief but vigorous discussion.

Indicative of the degree of interest in neurophysiology everywhere, but possibly illustrating regional differences in the kind of interest, a group of 23 workers, chiefly American and Canadian, met in New York during the week following the Ciba conference for the third annual Macy Foundation Conference on the Nerve Impulse. Discussion centered principally on mechanisms at the unit level and on similarities and differences between axon and synapse. J. Z. Young, however, challenged neurocytologists and physiologists to formulate new questions designed to reveal the meaning and relationships of such extensive synaptic fields and complexly structured populations of units as occur in the cerebral cortex.

It is expected that each of these meetings will be recorded in a published volume that will include the discussions.

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Scientists in the News

J. Burns Amberson, visiting physician in charge of the Chest Service of Bellevue Hospital, New York, has received the 1952 Trudeau Medal for the "most meritorious contribution on the cause, prevention, or treatment of tuberculosis." The medal was established in 1926 in memory of Edward Livingston Trudeau, first president of the association, and is awarded annually by the National Tuberculosis Association. The first Will Ross Medal for distinguished contribution to the tuberculosis control movement in a nonmedical field was presented to **Homer Folks**, of Yonkers, N. Y., retired executive director of the New York State Charities Aid Association and a former president of the Tuberculosis Association. This medal was named in memory of a volunteer worker who devoted many years of service to tuberculosis work.

David A. Andrews, geologist with the Foreign Geology Branch of the U. S. Geological Survey, has returned to Washington, D. C., after more than 3 months in Thailand as consultant on the Thai Coal Program. He also visited Formosa and the Philippines for consultations regarding their future mineral programs.

J. Dabney Burfoot, Jr., of the Department of Geology at Cornell, has been appointed assistant dean of the College of Arts and Sciences. Professor Burfoot has been a member of the geology staff since 1929 and secretary of the University Faculty since 1950. He was assistant to the dean of the College of Arts and Sciences and chairman of its advisory board for undergraduates from 1946 to 1950.

Chieh-Chien Chang, winner of a Guggenheim fellowship, will leave for Europe in September to investigate the application of mathematics to aeronautical problems of high-speed aircraft and missiles. At present dividing his time between the U. S. Air Force Air Research and Development Command and Johns Hopkins University, Dr. Chang will study in British universities and lecture in England and other European countries during the one-year period of the Guggenheim grant.

Bob Considine, International News Service columnist, and **Albert Q. Maisel**, free-lance writer, were the winners of the Lasker Medical Journalism Awards for outstanding reporting on medical research and public health in the newspaper and magazine fields, respectively, during 1951. The Albert and Mary Lasker Foundation announced also a special citation for **Selig Greenberg**, Providence, R. I., newspaperman. Mr. Considine won in the newspaper field for his series of six articles entitled "How Soon Will We Conquer Cancer?" Mr. Maisel was selected in the magazine field for his article "Scandal Results in Real Reforms," published in *Life* magazine in November 1951. Mr. Greenberg was given a special citation for his series of 22 articles on "Medicine in Crisis," published in the *Providence Journal and Evening Bulletin*. The awards are administered by the Nieman Foundation for Journalism, under the auspices of the National Association of Science Writers.

C. J. Gilgut, a staff member at the University of Massachusetts Field Station, Waltham, since 1934, has been appointed to fill the position of extension plant pathologist held by the late **Oran C. Boyd**.

Wayland J. Hayes, Jr., senior surgeon of the U. S. Public Health Service, and chief, Toxicology Section, Technical Development Branch, Communicable Disease Center, Savannah, Ga., participated in the International Congress of Comparative Pathology at Madrid. He is also visiting laboratories in England, France, Italy, and Switzerland.

William F. Hewitt, Jr., of the Department of Physiology, Howard University School of Medicine, has accepted appointment as professor and head of the Department of Physiology and Pharmacology in the Des Moines Still College of Osteopathy and Surgery.

Jack N. Hunt, senior lecturer in physiology at Guy's Hospital Medical School, London, is spending part of this year in New York City working in the Gastroenterology Research Laboratory of the Mount Sinai Hospital under the direction of Franklin Hollander. Dr. Hunt will be in this country for a protracted period under a fellowship from the Rockefeller Foundation.

Hudson Jost has been appointed professor of psychology and head of the department at the University of Georgia. Associate professor in the Department of Neurology and Psychiatry of the University of Ten-

nessee College of Medicine, he also serves as director of the Psychophysiological Laboratories at Gailor Psychiatric Hospital, teaching unit of the College of Medicine.

In recognition of his contributions to geological science, the Geological Society of London has elected **Esper S. Larsen, Jr.**, of the U. S. Geological Survey, as one of its foreign members.

Heinz A. Lowenstam, invertebrate paleontologist and paleoecologist, has been appointed to the geological sciences faculty at the California Institute of Technology. At present associate professor of geology at the University of Chicago, he will succeed **Charles W. Merriam**, who has returned to the U. S. Geological Survey. Professor Lowenstam has served as curator of paleontology at the Illinois State Museum and associate geologist of the Illinois State Geological Survey. He was a research associate in geology at the University of Chicago, 1948-49, and was appointed associate professor in 1950.

Joseph L. McDonald, professor of economics, will succeed **Lloyd K. Neidlinger** as dean of Dartmouth College. Professor McDonald has taught economics at Dartmouth since 1923.

Karl B. McEachron, General Electric engineer and authority on lightning, has received the 1952 award of the Engineering Societies of New England. The New England Award is conferred not oftener than once each year on a living engineer, resident of New England, whose outstanding work and character merit recognition by his fellow engineers of the New England area.

Millicent C. McIntosh, dean of Barnard College, will assume the new title of president of Barnard College on July 1 under the terms of a new agreement between the trustees of Columbia University, the parent institution, and the women's undergraduate college. She has served as dean since 1947. Mrs. McIntosh will retain her rank as dean of the university and will continue to sit on the University Council with other deans of Columbia.

Leo E. Melchers, who has been at Kansas State College 39 years and head of the Department of Botany and Plant Pathology for 35 years, will retire from administrative duties July 1. He will remain in the department as professor of botany and devote his time to teaching, research, and writing.

Adelmo Panella, of the Italian Institute of Scientific Research, who is interested in arid lands, and **Constantino A. Fasso**, assistant professor of hydraulics at the Polytechnic Institute of Milan, are in this country to complete studies which they hope will enable them to combat the effects of droughts and floods in their homeland.

S. Ralph Powers, head of the Department of Natural Sciences at Teachers College, Columbia University, for the past 24 years, is retiring from that position

and will become professor emeritus. In 1951 he was vice president and chairman of AAAS Section Q. He has also been chairman of a Unesco committee which studied science courses and equipment in U. S. schools and colleges.

Griffith E. Quinby, U. S. Public Health Service surgeon, was recently transferred from the Malaria and Typhus Appraisal Unit of the Communicable Disease Center in Atlanta, to the Toxicology Section of the Technical Development Branch, Savannah.

Recent visitors at the USDA Eastern Regional Research Laboratory, Philadelphia, included **Saifur Rahman**, of East Pakistan; **J. Boldingh**, Unilever Research Laboratory, Zwijndrecht, Holland; and **Louis Dejoie**, president, Etablissements Agricoles et Industriels, Haiti.

With more than 35 years of experience in anthracite and bituminous coal mines, **Seth T. Reese**, mining engineer in the Health and Safety Division of the Bureau of Mines, has been named chief of the Accident Analysis Branch. Mr. Reese, succeeding **Forest T. Moyer**, who has been transferred, will supervise the compiling of accident statistics from the mineral industries, including employment and production data used in studying labor problems and production records.

Nila Banton Smith has been appointed director of the New York University Reading Institute. Dr. Smith has been a teacher and supervisor of reading for the Detroit Public Schools, an associate professor at Indiana University, and a professor at the University of Southern California. In 1948, she was appointed a lecturer at the NYU School of Education, and last year she was named an adjunct professor of education, in charge of the graduate teacher training programs in remedial reading. The Reading Institute of New York University since 1936 has served elementary school children who are retarded in reading, secondary and college students who wish to read better and to develop more effective study skills, and business and professional men and industrial executives who wish to increase their speed and comprehension.

H. B. Squire, senior principal scientific officer of the Aerodynamic Division in the United Kingdom's National Physical Laboratory, has been appointed to the Zaharoff chair of aviation at the Imperial College of Science and Technology, London. He succeeds **A. A. Hall**, who, last year, was made director of the Royal Aircraft Establishment, Farnborough.

Bradley Stoughton, professor emeritus of metallurgy at Lehigh University, recently received a Department of the Army award for his contribution to the World War II effort in industrial intelligence. Dr. Stoughton is director and consulting metallurgist of the Lukens Steel Company, Coatesville, Pa. He served as London representative of the Technical Industrial Intelligence Committee, which worked closely with the Joint Chiefs of Staff during the war.

Education

A **Communicable Disease Workshop** is being held in Lima, Peru, June 30-Aug. 8 under the sponsorship of the Pan American Sanitary Bureau and WHO. Zella Bryant, chief nurse of the USPHS Division of Chronic Disease and Tuberculosis, will help in planning the program. Workshop teachers will be from PASB's nursing staff and from public health agencies and schools of nursing in Brazil, Chile, and Panama.

Lehigh University has named Allison Butts head of the Department of Metallurgy, effective Aug. 1. He will succeed Gilbert E. Doan, who is leaving to join the Koppers Company. The promotion of Hugh R. Gault to professor of geology has been announced; and Richard M. Davis, economics; Roger E. Kolm, civil engineering; Raymond H. Snyder, sanitary engineering; and Albert Wilansky, mathematics, have been promoted from assistant to associate professors. The Hillman Award, given annually to the member of the Lehigh faculty who is deemed to have "done most toward advancing the interests of the university," went to Adelbert Ford, head of the Department of Psychology. Lynn S. Beedle, assistant director of Fritz Laboratory, and Dr. Davis were joint recipients of the Alfred Noble Robinson Award for the faculty member judged to have given "outstanding performance in the service of the university."

J. Axel Höjer, former president of the Swedish Medical Board, and an expert on preventive medicine, will head a newly inaugurated **Medical College** in the Federated State of Travancore-Cochin, India. Dr. Höjer has been commissioned by WHO to set up the college, the only one in the state. Special emphasis will be placed on sanitation and hygiene, as well as on preventive medicine in general.

The **Medical College of Virginia** has invited Bo Norberg, head of the clinical laboratory of the Sabbatsberg Hospital, Stockholm, to establish an enzyme laboratory, devoted to research into conditions of survival of the blood corpuscles.

E. E. Lewis, of **Ohio State University's** College of Education, has left for Guam to serve until Jan. 31, 1953, as a coordinator of teacher education and higher education. A five-year cooperative program, entire cost of which will be paid by the government of Guam, has been worked out between the university and J. R. Palomo, former faculty member who is now director of education on the island. Dr. Lewis will be relieved by Leonard O. Andrews, who will remain until Sept. 1. Thereafter, the terms of service of OSU representatives will run for 15 months. The Guam Teachers' College will be officially opened this summer, and students completing a two-year post-high school course will be accepted for enrollment at Ohio State.

The **Pacific Science Board** is continuing for the third year the cooperative program of coral atoll

research in the South Pacific. A study of Raroia in the Tuamotus Archipelago will be made by a seven-man field party consisting of Norman D. Newell, geologist, head of the project; J. V. Byrne, of Columbia; Joseph P. E. Morrison, U. S. National Museum; Robert R. Harry, Academy of Natural Sciences, Philadelphia (financed by a special grant from George Vanderbilt); Maxwell S. Doty, University of Hawaii; W. J. Newhouse, University of New Hampshire; and Bengt Danielsson, anthropologist, of Johannesburg, Sweden. Collections made by the party will go to the National Museum, the American Museum of Natural History, the Bishop Museum, the Academy of Natural Sciences, and the California Academy of Sciences. Financial assistance has been given by the Office of Naval Research, and the French government of Oceania will provide transportation between Tahiti and Raroia.

Grants and Fellowships

The **American Heart Association** has established an annual award to be known as the Howard W. Blakeslee Award, in tribute to the Associated Press science editor who died May 2. The award will be presented each year to the individual whose creative efforts in any medium of mass communication—press, magazines, radio, television, films, and books—contribute most to public understanding of the cardiovascular diseases. Mr. Blakeslee was one of the founders of the National Association of Science Writers, and the NASW has appointed a committee to work with the AHA in developing plans for setting up the award.

Baxter Laboratories, Inc., of Morton Grove, Ill., is continuing its graduate fellowships in medical science which were initiated last year. Ten fellowships for 1952-53 have been awarded and in addition two short-term fellowships.

National Vitamin Foundation has approved nine grants, totaling \$39,000, for research on vitamins and nutrition. Largest amount (\$7950) went to the Harvard University School of Public Health for a study of the influence of nutritional factors on the metabolism of alcohol; L. D. Greenberg and J. F. Rinehart, of the University of California Medical School, received \$7500 for study of the fundamental biochemical and morphologic pathology of B-vitamin deficiencies in the rhesus monkey; and Roberto A. Funaro, Nutrition Clinics Fund, will complete studies in Italy on the effect of vitamin B₁₂ on the growth of under-sized children on low protein diets.

Public Health Service research grants totaling 176 have been approved for 206 investigators in 100 institutions, located in 34 states, including the District of Columbia, and in three foreign countries. The amount approved was \$1,831,563. Fellowship awards totaling 97 and amounting to \$254,500 have also been awarded. For full information concerning the PHS program, address the Division of Research Grants, Bethesda 14, Md.

In the Laboratories

Beckman Instruments, Inc., has established a new Special Products Division, under the direction of J. F. Bishop, for the study of special instrumentation problems of industrial organizations. These may include partly developed instrument designs or completed prototype instruments.

Fabric Research Laboratories, Inc., has appointed Milton M. Platt associate director of research in charge of all physical and engineering investigations. George Thomson, of MIT, has been made assistant director of research, in charge of chemical investigations. Chauncey C. Chu and Henry M. Morgan have been promoted to the senior research staff, and Myron J. Coplan, of the Institute of Textile Technology, Charlottesville, Va., has been added to the staff.

National Research Laboratories, of Canada, are adding new buildings to their Montreal Road site in Ottawa and making an addition to the supersonics laboratory, which was constructed last year. The Division of Applied Chemistry will occupy new quarters this summer, and the divisions of Building Research and Radio Electrical Engineering have begun new buildings. At Halifax, a maritime regional laboratory to serve the general needs of the sea provinces was recently opened on the campus of Dalhousie University.

The **New York Botanical Garden** has appointed Richard S. Cowan and John W. Wurdack assistant curators on the staff of the Herbarium. Dr. Cowan will leave in August for a year's study in England and on the continent, having been awarded a National Science Foundation fellowship. Other new appointees are Arthur Cronquist, who has been working under ECA auspices at the Jardin Botanique de l'Etat, Brussels, and George M. Bunting, of Michigan State College. Arthur Holmgren, of Utah State Agricultural College, is spending the summer at the Garden to assist in the study of Western U. S. intermountain flora; the Garden will eventually publish a flora of the region. Brother Alain has returned for the summer under a Guggenheim Fellowship; he has been working in Cuba for the past 17 years with Brother León on *The Flora of Cuba* and teaching at Colegio de la Salle, Havana.

Meetings and Elections

The **American Pharmaceutical Association**, in celebrating its centennial this year, will hold a Centennial Convention in Philadelphia, Aug. 17-21. The meeting of the A.Ph.A. will be followed immediately by meetings of the American Association of Colleges of Pharmacy, the National Association of Boards of Pharmacy, the American Society of Hospital Pharmacists, the American College of Apothecaries, and other groups, whose meetings will continue through Aug. 23. Since the actual organization of the association took place on Oct. 7, 1852, the national organi-

zation is planning a special program for Oct. 7 this year, to be transmitted by radio to each local and student branch. As their contribution to the centennial, the members of the Women's Auxiliary have created a special award to be given to senior women pharmacy students. Sixty-three such awards will be presented at commencement exercises or other functions this year.

The **American Society of Mammalogists**, meeting at Charleston, S. C., in April, elected the following officers: president, William J. Hamilton, Jr.; vice presidents, William H. Burt and William B. Davis; secretaries, Randolph L. Peterson and R. Kelson; treasurer, Viola S. Shantz.

The annual meeting of the Eastern Section, **Association of Geology Teachers**, was held at Vassar College, Apr. 4-5. Officers for the coming year are: president, A. Scott Warthin, Jr.; vice president, Shepard W. Lowman; secretary-treasurer, Milton T. Heald; editor, Lawrence Whitecomb. Membership is open to all persons interested in disseminating geologic information, whether or not they are actively engaged in teaching. For additional information about the organization, address Milton T. Heald, Department of Geology, West Virginia University, Morgantown.

The **Chemical Society** elected C. K. Ingold, of University College, London, president for the next two years, at a joint annual meeting of the society and the Royal Institute of Chemistry in Dublin Apr. 15-18. Eric Rideal, of King's College, London, is the retiring president.

Colorado-Wyoming Academy of Science has elected James W. Broxon president and Ernest R. Schierz vice president. Hugo G. Rodeck is executive secretary. The 1953 annual meeting will be held at Colorado College.

The **Minnesota Academy of Science** elected Ernst Abbe, of the University of Minnesota, president, and R. W. Darland, of the university's Duluth Branch, vice president at its annual meeting in St. Cloud recently.

The **Society for General Microbiology** elected H. J. Bunker president at its annual general meeting at Oxford last April. J. G. Davis and E. F. Gale were elected secretaries, and R. Lovell treasurer. In addition to a paper-reading session there was a symposium on "The Nature of Virus Multiplication," which was attended by more than 300 microbiologists. The papers and discussion in this symposium will be published in book form under the editorship of Paul Fildes and W. E. van Heyningen.

The following officers were elected by the **Wisconsin Academy of Sciences, Arts and Letters** at its annual meeting in April: president, Katherine G. Nelson; vice presidents, William H. Barber, Berenice Cooper, and Ella M. Martin; secretary-treasurer, Robert J. Dicke; librarian, Halvor O. Teisberg.

Technical Papers

An Unusual Type of Protection with the Carnation Mosaic Virus¹

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The demonstrable presence of a virus in a plant is currently regarded as a prerequisite for the protection of that plant against subsequent infection by the same virus or one of its strains. Evidence is presented here that an unusual form of protection may occur with carnation mosaic virus in at least one host.

The virus used in these studies was isolated from a variety of carnation growing in a local greenhouse. Transmission of the virus was effected in all cases by dusting carborundum on the leaves and then rubbing with infective juice.

Brierley and Smith (1) have reported that *Dianthus barbatus* is a satisfactory indicator plant for carnation mosaic virus. The senior author has propagated two seedling clones of this species (Nos. 20 and 26) that reacted to inoculation with this virus by the development of primary local lesions only. On the other hand, in a third seedling clone (No. 21), only systemic mosaic symptoms developed after inoculation.

Indications of this type of protection were first observed in leaves that had been detached from two plants, A and B, of Clone 20. Plant A was healthy; Plant B bore local lesions only on those leaves that had been previously inoculated with the virus. Leaves of Plant A, and apparently healthy leaves of Plant B, were detached, inoculated, and then floated on water in Petri dishes. As shown in Table 1, abundant lesions developed on the leaves from Plant A, but no lesions, except one, developed on the leaves of Plant B. Protection in the latter leaves appeared to be virtually complete.

To obtain further evidence of this protection, leaves on 3 healthy plants of each of Clones 20 and 26 were inoculated with the carnation mosaic virus. At the same time, apparently normal leaves on 3 previously inoculated plants of each clone were treated in the same way. As shown in Table 2 there was a highly significant decrease in the number of lesions that developed on the leaves of previously inoculated plants of Clone 20, as compared with the number developing on the leaves of the corresponding healthy plants of the same clone. Similarly, almost complete protection occurred in the previously inoculated plants of Clone 26.

According to the generally accepted hypothesis, these protected plants of Clones 20 and 26 should be systemically infected, although they remained sys-

¹ Contribution No. 1161 from the Division of Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa, Canada.

TABLE 1

PRODUCTION OF LESIONS BY CARNATION MOSAIC VIRUS ON LEAVES DETACHED FROM HEALTHY AND FROM PREVIOUSLY INOCULATED PLANTS OF *D. barbatus*, CLONE 20

No. of lesions/leaf	
From previously inoculated plant	From healthy plant
1	49
0	35
0	17
0	27
0	16
0	46
0	57
0	76

temically symptomless. In an attempt to test this hypothesis, 7 plants were selected that had previously been inoculated; protection had been demonstrated in 5 of these and could be presumed operative in the other 2. Juice transfers were made from apparently healthy leaves of these plants to 22 healthy plants—12 of Clone 20, 6 of Clone 26, and 4 of the more susceptible Clone 21. No symptoms appeared on any of the plants thus inoculated—i.e., the virus was not recovered from the apparently healthy leaves of the 7 plants. On the other hand, juice transfers from primary local lesions on the same 7 plants to healthy plants of Clones 20 and 26 readily induced symptoms on them—i.e., the virus was recovered without difficulty from the local primary lesions.

As far as the authors are aware, the form of protection described here is unique. The hypothesis suggested, and perhaps generally accepted, to explain the phenomenon of protection in plants requires that "protection extends only to cells that are actually infected . . ." (2). According to this view, a requisite of protection is the presence of the virus in the protected cells. Since no virus was recovered from the

TABLE 2

PRODUCTION OF LESIONS BY CARNATION MOSAIC VIRUS ON LEAVES ON HEALTHY AND PREVIOUSLY INOCULATED PLANTS OF *D. barbatus*

Test plants		Mean number of lesions/leaf/plant			
		Plant 1	Plant 2	Plant 3	Mean
Clone 20	Healthy	25.4	14.2	28.0	22.5
" "	Previously inoculated	4.5	2.4	7.6	4.8
Clone 26	Healthy	28.8	26.5	31.3	28.9
" "	Previously inoculated	0	0.8	0.8	0.5

For differences, $P < .001$ ("t" test)

protected leaves, there is in the experiments described above no evidence that such a condition obtains.

In order to fulfil the requirements of the accepted hypothesis, it is necessary to postulate that sufficient virus is present to afford protection to the apparently healthy leaves, but insufficient for transmission by the technique employed. The probability of such a condition occurring is minimized by the finding of other workers (3) that the dilution end point of this virus lies beyond 10^{-5} . However, from the known data, it is difficult at the present stage of the investigation to suggest any plausible alternative explanation for the phenomena described.

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Manuscript received March 26, 1952.

An Interspecific Cross Involving the Lima Bean *Phaseolus lunatus* L.¹

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The presentation of this brief account of preliminary success in the crossing of the Lima bean *Phaseolus lunatus* L. with the native wild thicklet bean *P. polystachyus* (L.) B. S. P. may provide bean breeders with an incentive to investigate further the possible contributions of this native source of germ plasm to any Lima-bean breeding program.

The cross *P. polystachyus* ♀ × *P. lunatus* ♂ was attempted an estimated 50 times with no success, but an estimated 100 attempts to effect the reciprocal cross resulted in the production of seven F₁ plants for which there is objective evidence that these are bona fide hybrids, although none of the plants has yet matured to the point of flower and seed production.

All the hybrids expressed completely or nearly completely the hypogaeal germination habit of the staminate, *P. polystachyus* parent. In two out of the seven a tendency toward the epigaeal habit of the pistillate parent was expressed by the slight elevation of the cotyledons to a level barely above the surface of the soil. With deeper planting this might even have escaped observation. In a Lima control the cotyledons were elevated to a height of 3 in. (Fig. 1).

One of the hybrids has as its pistillate parent a Lima selection resembling the commercial variety Fordhook. The Lima parent of the other six F₁ hybrids is itself an F₁ hybrid from a cross between a Fordhook-type selection and line M-270 from O. W. Norvell. M-270 is a small-seeded, colored-flowered,

¹ Florida Agricultural Experiment Station Journal Series, No. 55.



FIG. 1. Emergence behavior of *P. lunatus* × *P. polystachyus* F₁ hybrid (left) compared to that of *P. lunatus*. Soil removed to show hypogaeal position of the cotyledons of the hybrid. (Line drawings traced from a photographic negative.)

short-day, wild, viny type with a strong perennial tendency.

The principal objective of the *P. lunatus* × *P. polystachyus* cross has been to incorporate into the former species the hypogaeal germination habit of the latter in an attempt to solve the emergence problem in Limas, where a high mortality among seedlings is likely to result from the breaking of the hypocotyl ("neck-breaking") as it elongates in an often unsuccessful effort to push the extremely large Lima cotyledons through an encrusted or impacted soil. In *P. polystachyus* and several other bean species elongation of the stem of the plant involves only the development of the epicotyl and the plumule, and the cotyledons remain at planting depth because of the absence of elongation of the hypocotyl.

Apart from consideration of this one obviously valuable germination character is the possibility that a native species, such as *P. polystachyus*, having a comparatively wide geographic distribution, may possess yet unrecognized resistances to diseases and pests and may also possess physiological attributes of survival value. According to Small (1), *P. polystachyus* ranges from Florida as far north as Minnesota, Ontario, and Maine and as far west as Texas and Nebraska, so it seems apparent that the perennial rootstock at least has some degree of cold-hardiness even though the plant usually occurs in protected locations.

In view of the consideration that *P. polystachyus* may be a valuable source of germ plasm to bean breeders, that the realization that such a cross is possible may be of interest to taxonomists, and that

the writer has encountered in the literature no other instance of the involvement of *P. lunatus* in any interspecific hybrid combination, it was deemed advisable to publish now this preliminary report of progress, even though the subsequent breeding behavior of the F_1 hybrids is yet to be established.

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Manuscript received January 23, 1952.

Niacin and Niacinamide Biosynthesis in Insects¹

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It has recently been shown that niacin can be formed from tryptophan in mammals (1), but cannot be formed in the larval stage of insects, such as

¹ The authors are indebted to K. Nakamura, M. Takanami, and S. Higashi. This work was supported in part by a grant from the Science Research Fund No. 4009, Ministry of Education.

Drosophila melanogaster (2), *Tenebrio molitor*, and *Tenebrio confusum* (3), which require both tryptophan and niacin in their larval growth.

This paper reports an increase of the amount of niacin and niacinamide during the metamorphosis of the pupal stage in the silkworm *Bombyx mori*. We determined these two substances in various stages of the pupa, which live for a considerable period (7-12 days) without food. Female pupae of the Japanese and Chinese hybrid (J 115 x C 108) were used. The samples were kept at a constant temperature of 28° C.

The determination of niacinamide was made by Kato and Shimizu's method (4), and that of total niacin by the microbiologic assay method, using *Lactobacillus arabinosus*.

The results of the experiments are given in Tables 1 and 2 and in Fig. 1. It was found that in the period from the second to the eighth day both the total niacin and the niacinamide reached a maximum on the eighth day, and that the amounts of these substances were twice as great as on the second day. They suddenly decreased on the ninth day. The formation of total niacin was found to be greater than that of niacinamide at each period.

From the above results, we conclude that niacin and niacinamide are formed biosynthetically in silk-

TABLE 1
TOTAL NIACIN CONTENT OF SILKWORM PUPAE, DETERMINED BY THE MICROBIOLOGICAL ASSAY METHOD WITH *L. arabinosus*

Material and age in days	Wt of 5 fresh pupae (g)	Titration value (ml)	Calibration curve (γ)	Dilution factor	Content of total niacin (γ)	Total niacin content (γ/g)	Total niacin content (γ/individual)
Female pupae							
Second day	7.50	2.55	0.08	3150	252	33.6	50.4
" "	8.30	2.75	.09	3150	284	34.2	56.8
Fifth "	7.84	2.85	.10	3325	333	42.4	66.6
Sixth "	7.27	3.10	.12	3325	399	54.8	79.8
Eighth "	7.19	3.70	.18	3325	599	83.3	119.8
Ninth "	6.70	3.25	0.14	3588	502	74.9	100.4

TABLE 2
NIACINAMIDE CONTENT OF SILKWORM PUPAE, DETERMINED BY KATO AND SHIMIZU'S METHOD

Material and age in days	Wt of 5 fresh pupae (g)	Titration value (ml)		Nia- cina- mide added (γ)	Dilu- tion factor to total indi- viduals	Nia- cina- mide (γ) in total indi- viduals	Estimated value (γ), titrated with 2γ/ml of niacinamide standard solution		Dilu- tion factor	Recov- ery (%)	Nia- cina- mide con- tent (γ/g)	Nia- cina- mide con- tent (γ/indi- vidual)
		a	b				c	f = $\frac{acf}{b-a}$				
Female pupae												
Second day	7.50	0.080	0.120	10	6.0	120	0.160	0.240	120	96	16.0	24.0
" "	8.30	.085	.125	10	6.0	128	.170	.250	120	96	15.4	25.6
Fifth "	7.84	.105	.140	10	6.3	189	.210	.280	120	84	24.1	37.8
Eighth "	7.19	.125	.160	10	6.3	225	.250	.320	120	84	31.2	45.0
Ninth "	6.70	0.120	0.162	10	6.3	180	0.240	0.324	120	101	26.8	36.0

a, a', no niacinamide added.

b, b', niacinamide added.

$$\text{Recovery} = \frac{f' (b' - a')}{c} \times 100.$$

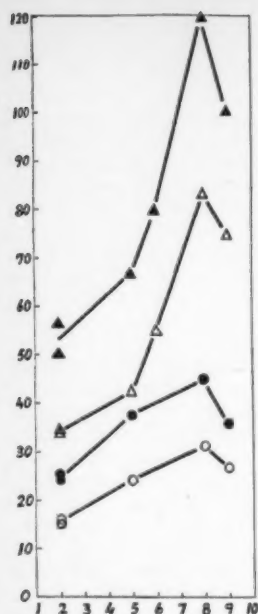


FIG. 1. Variation of the total niacin and niacinamide content in the pupal stage of *Bombyx mori*. Ordinate: content of total niacin and niacinamide (γ). Abscissa: age of pupae in days. \blacktriangle , Total niacin per individual; \bullet , total niacin per g.; \triangle , niacinamide per individual; \circ , niacinamide per g.

worm pupae, although we cannot yet identify tryptophan as the precursor.

It is natural that *Tenebrio* and *Drosophila* have no mechanism of niacin biosynthesis, because they receive niacin in their food in the larval stage, whereas according to Kikkawa (5) 3-hydroxykynurenine is absent or very scanty in the larval stage of the silkworm, but becomes suddenly increased biosynthetically at the beginning of the prepupal stage and is maintained through almost the whole pupal stage except the last short period. We can therefore readily suppose that the niacin biosynthesis is carried on in the pupal stage.

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Manuscript received December 18, 1951.

An Oxidative Metabolite of Desoxycorticosterone

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The general procedure of perfusing an isolated organ with a circulating medium enriched by the addition of a selected steroid precursor has found utility

both as a means of determining the metabolic path of the precursor under conditions resembling those present in the intact animal (1) and as a method of biosynthesis (2). We have employed this procedure in a study of the metabolism of desoxycorticosterone (DOC) in a mammalian liver.

The liver is known to play an important role in the inactivation of DOC, as judged by the failure of this hormone to elicit a full physiological response when it is administered orally or introduced into a site drained by the portal circulation (3, 4). Studies based on urinary excretion products (5-9) in various species have shown that the administration of DOC (or its acetate) is followed by an increased elimination of pregnanediol, generally isolated and characterized as sodium pregnanediol glucuronide. The amount of administered DOC which can be accounted for as pregnanediol usually varies from 1% to 15%. In Addisonian patients a similar conversion of 11-dehydrocorticosterone to 11-keto-pregnanediol has been reported (10). Assays of the blood sera of monkeys have indicated a partial transformation of DOC acetate into progesterone (11). The administration of progesterone is also known to give rise to pregnanediol (6) and to pregnane-3 α -ol-20-one (12).

More recently Schneider and Horstmann (13) have incubated DOC with rat liver tissue and have observed reduction of the conjugated unsaturated system in Ring A, shown by ultraviolet spectroscopy and by the isolation of allopregnane-3 β , 21-diol-20-one. These investigators have also demonstrated that extensive attack takes place on the side chain, involving cleavage or reduction beyond the stage of the α -glycol, as they observe a loss of formaldehydogenic steroids during incubation. This result is explainable by the formation of pregnanediol or, as Schneider and Horstmann suggest, by the possibility of cleavage to a 19-carbon atom steroid. There is, however, some evidence (14) that administered DOC does not give rise to 17-ketosteroids, and no metabolite of DOC having other than 21 carbon atoms has previously been reported.

In our procedure rat livers were perfused via the superior vena cava with oxygenated, citrated beef blood containing about 500 mg of added DOC per liter. Adsorbable constituents were removed from the hemolyzed perfusate by activated carbon, and these materials were then removed from the carbon by extraction with chloroform and benzene in a Soxhlet apparatus.

The Soxhlet extract was subjected to extensive chromatography on silica columns, terminating in a final column on which the steroidal portion was partitioned, on 65 times its weight of silica, into 40 fractions by means of increasingly polar mixtures of ethyl acetate and benzene. Elution in the vicinity of 1:2 ethyl acetate-benzene resulted in crystalline fractions containing unaltered DOC and a 20-carbon atom transformation product, difficult to separate by direct chromatography because of its close resemblance to DOC in its behavior on the column.

Identification of this material as 3-keto-4-etiochol-

enic acid followed from the assignment of its 3 oxygen atoms to an α,β -unsaturated ketone and a carboxylic acid group. A sample recrystallized from ethyl acetate for analysis melted at 244°–246° (totally immersed Anschütz thermometer; literature mp, variously 236°–262°). Calculated for $C_{20}H_{28}O_3$: C, 75.91; H, 8.92. Found: C, 76.01, 75.90; H, 8.99, 8.90. $[\alpha]^{27}_D + 156^\circ$ (chloroform). Ultraviolet absorption maximum at 241 m μ ($\log \epsilon$ 4.21). No depression of melting point was observed when this product was mixed with an authentic sample.

That 3-keto-4-etiocholenic acid was a true transformation product of DOC and not merely a normal constituent of the liver or the blood was concluded from the quantity of this product that was isolated. Thus, from the perfusion of 10.2 g of DOC a total of 3.1 g of crude, crystalline steroids was isolated. By direct chromatography and by extraction of the DOC-rich eluate residues with potassium bicarbonate solution, 340 mg of reasonably pure (minimum mp, 236°) etio acid was obtained. Therefore the conversion was 3.3%, the yield was 4.6%, and the etio acid represented 11% of the recovered crystalline steroids.

Evidence is lacking to demonstrate whether the relatively low recovery of crystalline steroids is due to more extensive degradation of DOC or to inadequacies in the isolation procedure, although indications are that both these factors are important. Total steroid recoveries from nonperfused blood samples treated by the same technique are known to average about 60%. The fate of a glucuronide in our procedure is not known, although it is quite possible that it would not be adsorbed from the perfusate and would be lost. Various amorphous fractions from chromatography are undergoing further investigation.

Turkitt (15) has shown that soil bacteria of the genus *Proactinomyces* oxidize cholesterol (via cholestenone) to 3-keto-4-etiocholenic acid. However, the formation of this etio acid by liver perfusion of DOC is considered remarkable, since the commonly recognized transformation to pregnanediol involves reduction at both the unsaturated ketone grouping and the side chain, whereas the formation of the etio acid is an oxidative change. There is, of course, the possibility that the perfused liver in our experiments had available a larger supply of oxygen than the liver in an intact animal.

Precedence for the degradative bio-oxidation of a steroid side chain by mammals can be found in the oxidation of cholesterol to the bile acid stage (16) and in the presence of radioactive carbon dioxide in expired air after intraperitoneal injection of radioprogesterone labeled at C_{21} (17).

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Manuscript received January 7, 1952.

The Aerial Transport of Mammalian Ova for Transplantation

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Since Heape (1) succeeded in transferring fertilized ova from one rabbit to another, Pincus (2) has employed the technique to determine the possibility of fertilization *in vitro* and parthenogenesis of rabbit ova. Chang (3) has been able to store *in vitro* at 10° C fertilized rabbit ova in the early stages and in the late blastocyst stage. The possible practical application of such transplantation techniques in agriculture and medicine has aroused interest in recent years. This note reports the first successful aerial shipment of fertilized rabbit ova for transplantation from one country to another.

Two Californian rabbits were superovulated and inseminated with the semen of a Californian buck at the Worcester Foundation for Experimental Biology. About 24 hr after insemination they were sacrificed and the Fallopian tubes were flushed with whole rabbit serum. Altogether, 74 fertilized ova at the 2-cell stage were recovered and placed in 4 small flasks (1 ml capacity) containing whole serum, with a drop of penicillin solution added. The flasks were packed in a small thermos flask containing 2 small ice balloons. The thermos was shipped from Boston by air to London and then by train to Cambridge.

The time interval from recovery of the ova to the time of transplantation was 27 hr, and the temperature in the thermos was 12° C at the time of packing and 19° C at the time of unpacking.

Three black does kept in the School of Agriculture at Cambridge University were intravenously injected with Prolan and two of them were successfully bred by a colored vasectomized buck to induce ovulation about 26 hr before transplantation. Midline incision was made on the recipients, and 5 segmented ova were placed into the ampulla of each Fallopian tube. Ex-

¹ We are indebted to J. Hammond and G. Pincus, and to J. D. Silveria, of Trans World Airlines, for providing facilities for this experiment.

amination of the ovaries, however, revealed that one recipient failed to ovulate. On the 32nd day after transplantation, 2 Californian offspring were produced by one recipient rabbit (Fig. 1). The percent-

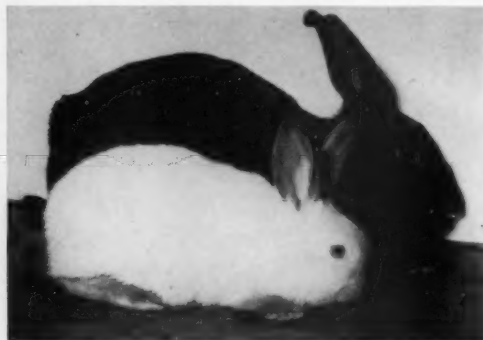


FIG. 1. Recipient English black doe with white Californian young.

age of normal development in these two cases is rather low—10%—when compared with ova stored at 10° C for 24 hr—37% (3).

The temperature in a thermos flask containing ice balloons, as determined in the laboratory, drops from 15° C to 2°–5° C within 1–2 hr, stays at 2°–6° C for about 10 hr, and then gradually rises to 25° C in 4–6 hr. From previous experiments (4), it is known that the normal frequency of development is rather low (6–24%) when the rabbit ova are stored either at 0°–5° C or at 15° C. The low percentage of development in the present experiment is perhaps due mainly to the variation of temperature at the time of shipping.

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Manuscript received January 12, 1952.

Identification and Lead-Uranium Ages of Massive Uraninites from the Shinarump Conglomerate, Utah¹

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During field work in southeastern Utah in July and August 1951, two samples of hard, massive uraninite were found in the Shinarump conglomerate of Triassic age. To our knowledge, the occurrence of pure, massive uraninite on the Colorado Plateau or in the Shinarump conglomerate has not been previously reported,

¹ Publication authorized by the director, U. S. Geological Survey.

although sooty uraninite from the Happy Jack Mine in San Juan County, Utah, has been described by Kerr (1) and others. These massive uraninites were collected in the course of an investigation of the origin of the carnotite deposits of the Colorado Plateau undertaken by the U. S. Geological Survey on behalf of the U. S. Atomic Energy Commission.

The authors have been studying the isotopic composition of the lead extracted from approximately 50 samples of uranium ore collected at different geographic localities and stratigraphic positions on the Colorado Plateau and are computing the ages from the Pb^{206}/U^{238} , Pb^{207}/U^{235} , and Pb^{207}/Pb^{206} ratios. The average apparent Pb^{206}/U^{238} age of all samples studied containing more than 0.1% uranium is 77.3 million years.

TABLE 1

SEMIQUANTITATIVE SPECTROGRAPHIC ANALYSES
OF URANINITE SAMPLES
(Analysts, Charles Annell and C. L. Waring,
U. S. Geological Survey)

Locality	Percentages*			
	Over 10	10–1.0	1.0–0.1	0.1–0.01
Happy Jack Mine† U	—	Ca Pb Fe Al Si	Cu Y Zn V Ba Mn Sr	
Happy Jack Mine‡ U	—	Ca Pb Fe Al Si	Cu Y Zn V Ba Mn Sr	
Shinarump No. 1 claim† U	—	Ca Pb Fe Al Si Co Ba Ni Mn	V Y Zn Sr	
Shinarump No. 1 claim‡ U	Ba Si Pb	Ca Fe Al Co Sr Zn Ni	V Y Mn Ti	

* Th and Ce, with sensitivity limits of 0.1%, were not detected on the spectrogram.

† Hand-picked fragments of nearly pure uraninite.

‡ Large samples, chemically analyzed.

One sample of massive uraninite is from the Happy Jack Mine, White Canyon, San Juan County, Utah. It was obtained from a nearly horizontal tabular or lenslike mass of uraninite that ranges in thickness from 1/16" to 3/4" and is approximately 1 1/2' in the exposed long dimension. Sandstone containing finely disseminated uraninite and impregnated or veined with pyrite, chalcocite (?), covellite, and chalcopyrite surrounds the small tabular mass of uraninite. The specimen was collected near the foot of a working face at the end of a short drift approximately 200' from the main portal. The thickness of the conglomerate and sandstone at this portal is about 20' (2).

The other sample of massive uraninite is from the Shinarump No. 1 claim, Seven Mile Canyon, Grand County, Utah. It was collected from a pillar at the portal of the prospect. This uraninite occurs as a replacement of woody material. There are also disseminated uraninite, pyrite, and secondary uranium minerals in the surrounding sandstone.

The specific gravity of carefully selected uraninite fragments was measured as 9.1 for the specimen from the Happy Jack Mine and 8.6 for the specimen from the Shinarump No. 1 claim. These carefully picked fragments, when studied by x-ray powder diffraction methods by E. A. Cisney, of the U. S. Geological Survey, gave face-centered cubic patterns (unit cell size of 5.43 ± 0.02 Å) that are identical with those of uraninite.

The results of semiquantitative spectrographic analyses of both the fragments used for specific gravity determinations and the larger samples of uraninite that were analyzed chemically are given in Table 1.

The uraninites were analyzed volumetrically for uranium by the cupferron method and colorimetrically for lead by the dithizone method (Table 2). Of the

TABLE 2

PRELIMINARY QUANTITATIVE CHEMICAL ANALYSES OF URANINITE FOR URANIUM, THORIUM, AND LEAD

Locality	U (%) [*]	Th (%) [*]	Pb (%) [†]
Happy Jack Mine	73.46	< 0.01	0.74
Shinarump No. 1 claim	55.90	< 0.01	1.43

^{*} Analyst, Harry Levine, U. S. Geological Survey.

[†] Analyst, Robert Milkey, U. S. Geological Survey.

14 analyses of uraninite published in *The System of Mineralogy* (3), only four specimens contain more uranium than the Happy Jack uraninite and only two contain less total lead. The high uranium content of the Happy Jack uraninite is due not only to the purity of the specimen but also to the relatively small amounts of radiogenic Pb^{206} and Pb^{207} in the sample.

Lead was extracted from the large samples of uraninite and, after purification, precipitated as the iodide. The iodide was submitted for mass spectrographic analyses to Roger F. Hibbs at the Carbide and Carbon Chemicals Co., Y-12 Plant, Mass Assay Laboratory, Oak Ridge, Tenn. The percentage abundance of the lead isotopes is given in Table 3, together with a published analysis of common lead from the Tucson Mountains, Ariz.

Lead is deposited in many radioactive minerals at the time of their formation. The isotopic composition of the common lead so deposited should be known in order that the correction can be made for the amount of Pb^{206} , Pb^{207} , and Pb^{208} not produced by radio-

TABLE 3

ATOM PERCENTAGE ABUNDANCE OF LEAD ISOTOPES

Locality	Percentage abundance			
	Pb^{204}	Pb^{206}	Pb^{207}	Pb^{208}
Happy Jack Mine	0.15	88.15	6.43	5.27
Shinarump No. 1 claim	0.84	53.55	14.73	30.88
Tucson Mountains, Ariz.*	1.37	25.20	21.27	52.17

* Wulfenite and vanadinite analyzed by Nier (4).

active decay in the mineral. As Pb^{204} is not known to be the end product of any radioactive decay series, the percentage abundance of this isotope in the analyses was used as an index of the common lead present. Tentative corrections for the common lead in the uraninites have been made, using Nier's analysis (4) for the isotopic composition of the lead in wulfenite and vanadinite from the Tucson Mountains (Table 3). This common lead was chosen because it has been contaminated with slightly less radiogenic Pb^{206} and Pb^{207} than the six Colorado Plateau common leads that we have studied. The use of a vanadinite type of lead, therefore, will give slightly higher Pb^{206}/U^{238} ages than the use of any of the Plateau common leads. The tentative percentage of common lead present in uraninites from the Happy Jack Mine and the Shinarump No. 1 claim is 10.51 and 60.37, respectively. Final corrections for common lead in the Happy Jack uraninite will be made as soon as the isotopic analysis of a galena sample collected from the Happy Jack Mine has been completed.

Table 4 shows the tentative percentage abundance

TABLE 4

CALCULATED PERCENTAGE ABUNDANCE AND CALCULATED GRAMS OF RADIOGENIC LEAD PER GRAM OF SAMPLE

Locality	Percentage abundance radiogenic		Grams of radiogenic	
	Pb^{206}	Pb^{207}	Pb^{206}	Pb^{207}
			Per g sample	Per g sample
Happy Jack Mine	85.39	4.10	0.0063	0.00030
Shinarump No. 1 claim	38.01	1.62	0.0054	0.00023

of the radiogenic Pb^{206} and Pb^{207} and the amount of these two leads in the two uraninites.

The Pb^{206}/U^{238} ages given in Table 5 were com-

TABLE 5

Pb^{206}/U^{238} AND Pb^{207}/U^{235} RATIOS AND THEIR CALCULATED AGES
(To the nearest 5 million years)

Locality	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	Age in million years calculated from	
			$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$
Happy Jack Mine	0.00866	0.0581	65	65
Shinarump No. 1 claim	0.00980	0.0584	75	65

puted using Wickman's nomograph (5). The Pb^{207}/U^{235} ages were calculated from the radioactive decay formula. The Pb^{207}/U^{235} ages, particularly for the Shinarump No. 1 uraninite, are less reliable because the corrections introduced by the assumed isotopic composition of the common lead have a proportionally greater effect on the Pb^{207}/U^{235} age calculations in

samples that are contaminated with large amounts of common lead. The Pb^{207}/Pb^{208} ages are not presented at this time because this age calculation is even more sensitive to common lead corrections than the Pb^{207}/U^{235} ages.

As shown in Table 6, the calculated ages of the

TABLE 6

Pb^{206}/U^{238} AGE OF URANINITES FROM THE COLORADO FRONT RANGE AND FROM THE COLORADO PLATEAU

Locality	Pb^{206}/U^{238} age in million years*
Wood Mine, Gilpin Co., Colo. (6)	57.3
Wood Mine, Gilpin Co., Colo.†	60
Gilpin Co., Colo. (6)	59.8
Iron Mine, Gilpin Co., Colo.‡	70
Happy Jack Mine, San Juan Co., Utah	65
Shinarump No. 1 claim, Grand Co., Utah	75

* These ages have been corrected for common lead, using the isotopic composition of the lead in the wulfenite and vanadinite (4).

† Specimen from the U. S. National Museum (USNM 83629), courtesy George Switzer. Analyzed chemically by U. S. Geological Survey. Isotopic analysis by Carbide and Carbon Chemicals Co., Y-12 Plant, Mass Assay Laboratory, Oak Ridge, Tenn. Age expressed to nearest 5 million years.

‡ Specimen collected by George Phair, U. S. Geological Survey. Analyzed chemically by U. S. Geological Survey. Isotopic analysis by Carbide and Carbon Chemicals Co., Y-12 Plant, Mass Assay Laboratory, Oak Ridge, Tenn. Age expressed to nearest 5 million years.

uraninites from the Shinarump conglomerate of Utah are of the same order of magnitude as the early Tertiary age of uraninites of the Colorado Front Range. However, using the geologic time scale proposed by Holmes (6), the Shinarump conglomerate is estimated to be approximately 160 million years old.

If the ages calculated from the foregoing data for the uraninites in the Shinarump conglomerate, and the average age (77.3 million years) for the carnotite deposits of the Salt Wash sandstone member of the Morrison formation (Upper Jurassic), are close to the true ages of these ores, then these uranium-bearing minerals were probably formed in the sediments in late Mesozoic or early Tertiary time. This interpretation differs markedly from the earlier conclusions, based on field evidence, by Hess (7), Webber (8), and Fischer (9), that the uranium minerals were introduced into the sandstones of the Colorado Plateau during or soon after deposition of the sandstones. Careful study is continuing in order to resolve the uncertainties in interpretation of both field and laboratory data so that a satisfactory hypothesis of origin of these ores may be established.

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Manuscript received January 29, 1952.

The Isolation of Progesterone from Human Placentae¹

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Progesterational activity has been detected by biological methods in the placenta (1), the urine (2), and the blood (3) of pregnant women and also in the blood of nonpregnant women (4). Attempts to isolate progesterone from human tissues, however, have hitherto been unsuccessful (5-8).

We are reporting the isolation of progesterone from normal postpartum placentae. Since the greatest yield yet reported has been obtained by treatment of whale corpora lutea with diute NaOH, we have utilized this procedure (9). Two characteristics served as guides in the isolation: first, progesterational activity as measured by the Hooker-Forbes microassay technique (10); second, the unsaturated α - β structure in Ring A, as determined by its absorption maximum at 240 μ . It was later found that all fractions that showed more than traces of progesterational activity also demonstrated an absorption maximum at 240 μ . Other minor fractions had peaks at this wavelength but did not exhibit significant progesterational activity.

Placentae were frozen in the deep-freeze and finely ground before being completely thawed. The tissue was then treated with approximately equal volumes of 5% NaOH for two days at room temperature. The resulting liquid was extracted five times with equal volumes of redistilled ether, back-washed with water until neutral, and then evaporated to dryness. Approximately 3 mg of neutral lipids was obtained from each gram of crude tissue.

Ketones were separated from the neutral ether extract by means of Girard's Reagent T (11). Preliminary chromatography on Magnesol: Celite (ratio 5:1) was followed by fractional chromatography on activated alumina (Merek) and Hyflow Supercel, using, for elution, mixtures of hexane, benzene, or alcohol in various proportions. In the final stages, the

¹ Supported by grants-in-aid from the U. S. Public Health Service.

² U. S. Public Health Service research fellow of the National Institute of Arthritis and Metabolic Diseases.

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⁴ The authors wish to acknowledge the generous supplies of placentae obtained for them by Emil G. Holmstrom, professor of obstetrics and gynecology, College of Medicine, University of Utah.

mixture was acetylated and chromatographed on alumina and then Magnesol: Celite, using a hexane-acetone system. Details of the chromatographic procedures will be published subsequently. The compound was crystallized from acetone: pentane, and the final purification was achieved by sublimation in high vacuum.

The white crystalline solid finally obtained melted at 124°-125°; mixed mp with progesterone, 123.5-125° (progesterone mp 123°-125°). The derivative made with dinitrophenylhydrazine melted at 288°-294° as compared with known progesterone bis-dinitrophenylhydrazone, which melted at 287°-297°. The amount of isolated progesterone was roughly 1 mg/kg fresh tissue and seemed sufficient to account for the known progestational activity of the starting material.

From the biological point of view, the isolation of progesterone from placenta provides evidence in support of the concept that this organ secretes progesterone during the latter part of pregnancy. Since progesterone has been isolated from tissues of the whale, sow, and steer, it also suggests that the human has adopted the same chemical structure as other mammals for progestational action.

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Manuscript received January 18, 1952.

Effects of Whole Body Exposure to Irradiation upon Subsequent Fertility of Male Rabbits¹

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The biological action of ionizing radiation on the functional activity of the sperm has been the subject of a number of studies in recent years. Most of the interest, however, has been centered on the effects of direct irradiation of the sperm *in vitro* (1-3) or of localized radiation of the testes (4-9), with the major

parts of the body protected by a lead shield. Few studies have dealt with the effects of whole body exposure to relatively low levels of radiation, prior to mating, upon the subsequent fertility of the exposed male (10, 11). Most of the observations concerning the effects of whole body exposure to radiation on fertility have been incidental to other studies.

The data in this report are the results of a preliminary investigation of the effects of whole body exposure of male rabbits to x-rays upon their subsequent fertility when mated to normal females.

The mature male and female rabbits used in this study were purchased from commercial rabbit breeders. All males were test-mated prior to treatment to insure the use of potentially fertile males.

An estimate of the effects of irradiation of the male on his potential fertility was obtained by comparison of the data obtained from normal (test) females bred to irradiated males with similar data obtained from normal (control) females bred to nonirradiated males. The evaluation of the potential fertility of each male was based on (1) the initial fertilization rate of ova as determined 28-72 hr after mating, (2) the fetal death rate, as determined between the 9th and 24th day of pregnancy, and (3) the litter size and the viability of the young.

The initial fertilization rate of ova was studied only in matings made within the first 2 weeks of the male post-treatment period, and the data on fetal mortality, litter size, and viability of young born were obtained from matings made throughout the 108-day experimental period. Three females, in which none of the eggs were fertilized, were excluded from the summary of data on the initial fertilization rate.

Abdominal palpations of all females, not sacrificed within 72 hr after mating, were done on the 10th day after mating and at weekly intervals thereafter for evidence of pregnancy (12). No females diagnosed as not pregnant on the 10th day were sacrificed for the determination of the fetal mortality rate. Although this may have introduced a slight error, every effort was made to prevent unduly penalizing the male by charging him with the failure of fertilization when, in fact, the female may have been at fault.

Eight males were bilaterally exposed to whole body irradiation administered with a General Electric Maxitron x-ray machine. Three levels of radiation, measured in air, were given: 2 males received 100 r, 4 received 200 r, and 2 received 300 r. The factors of radiation were 250 kvp, 30 ma, hvl 0.4 mm copper, inherent filtration 1 mm aluminum, added filtration 3 mm aluminum, TSD 93.7 cm, rate 48 r/min.

Experimental matings to test females (nonirradiated) were started as soon after irradiation as possible, and all males were mated at least one time during the first week after exposure. The frequency of postirradiation matings was determined by the availability of estrous females. Matings of 3 nonirradiated males provided the control data.

The chi-square test for homogeneity was used as the test of significance (13).

¹ Published with the approval of the director of the Tennessee Agricultural Experiment Station.

² From the Veterinary Corps, U. S. Army.

TABLE 1
FETAL MORTALITY IN NORMAL FEMALE RABBITS MATED TO CONTROL OR IRRADIATED MALES

Treatment of males	No. of matings	No. of corpora lutea*	No. of fetuses†		Percentage of eggs missing	Percentage fetal loss
			Alive	Dead		
Control	7	74 (10.6)	59 (8.4)	0	20.3	0.0
All irradiated males	26	318 (12.2)	146 (5.6)	71	31.8	32.7
100 r	6	92 (15.3)	46 (7.7)	18	30.4	28.1
200 r	14	163 (11.6)	74 (5.3)	34	33.8	31.5
300 r	6	63 (10.5)	26 (4.3)	19	28.6	42.2

* Numbers in parentheses are the average number of corpora lutea per female.

† Numbers in parentheses represent the average potential litter size if all live to birth.

TABLE 2
FERTILITY IN NORMAL FEMALE RABBITS MATED TO CONTROL OR IRRADIATED MALES

Treatment of males	No. of matings	No. of matings fertile	No. of litters born*	No. of young born†	Av litter size†	Av litter size born alive per mating
Control	34	31 (91.2%)	30 (1)	233 (223)	7.7 (7.4)	6.6
All irradiated males	57	47 (82.5%)	38 (9)	244 (218)	6.4 (5.7)	3.8
100 r	15	12 (80%)	10 (2)	60 (51)	6.0 (5.1)	3.4
200 r	26	23 (88.5%)	19 (4)	122 (116)	6.4 (6.1)	4.5
300 r	16	12 (75%)	9 (3)	62 (51)	6.9 (5.7)	3.2

* Figures in parentheses in this column are the numbers of litters resorbed.

† Figures in parentheses in these columns are the young born alive.

The initial fertilization rate was 78.3 and 77.0%, respectively, in the control and test female groups. A total of 115 ova, of which 90 were fertilized, was recovered from 10 control females; a total of 74 ova, of which 57 were fertilized, was recovered from 9 test females. The percentage recovery of ova in the two groups, based on the number of ovulation points counted in the ovaries, was 91.3 and 86.1, respectively. These data failed to demonstrate that irradiation, within the levels used in this study, significantly affected the ability of the sperm to fertilize the ova in normal females during the first 2 weeks of the postirradiation period.

The fetal mortality rate was zero and 32.7% for the control and all test female groups, respectively (Table 1). The differences between the control and each of the test groups are highly significant ($P < .01$). The failure to find any fetal deaths in the control group is not in agreement with the work of Hammond (14) in which it was found that approximately 9% of the eggs ovulated were subsequently represented by atrophic fetuses. However, if one assumes that a 10% fetal death loss is to be expected, the differences between the control and test groups are still highly significant. The differences between the three test female groups are not significant.

The differences between the number of corpora lutea and the total number of fetuses are expressed as "percentage of eggs missing" in Table 1. The 20.3% of eggs missing in the control female group is in close agreement with the 23.7% of eggs missing found by Hammond (14). However, the 31.8% of eggs missing in the test female group is definitely higher and ap-

proaches a level of significance ($P = .052$). The fact that there was a greater loss of eggs in each of the test groups is suggestive either of some interference with fertilization or of such early fetal death that the decidua reaction resulting in development of the placenta was not initiated. The authors are inclined to accept the latter possibility at the present time.

This interpretation seems to be in accord with the finding of Amoroso and Parkes (1) that, after insemination of female rabbits with sperm exposed *in vitro* to 250, 500, or 1000 r by x-rays, an increasing proportion of the tubal ova obtained about 40 hr after ovulation showed arrest of segmentation. A similar phenomenon has been observed in females mated to male rabbits exposed to 400, 500, or 600 r (unpublished data in this laboratory). However, it should be noted that in this study there is no trend toward a higher percentage loss of eggs associated with the higher dose of irradiation received by the male parent.

The difference in percentage of matings fertile, 91.2 and 82.5, respectively, between the control and test female group is not significant. One male that received 100 r was sterile at 51 days, one that received 200 r was sterile at 50 days, and one that received 300 r was sterile at 95 days after irradiation. All other treated males continued to produce some pregnancies throughout the experimental period. No control males became sterile during the study.

The data on the number of whole litters resorbed (Table 2) were obtained from females which were diagnosed as pregnant on the 10th day after mating and which subsequently failed to produce litters. Although the difference between the control and test

group is not significant, it is interpreted as an indication that irradiation of the male prior to mating may increase the frequency of resorption of whole litters in rabbits.

The difference in numbers of young stillborn, 4.3 and 11.1%, respectively, in the two groups is highly significant ($P < .01$). The litters of 2 control and 3 test females which did not prepare a nest prior to parturition were excluded from the summary, because of the possibility that the young may have died from exposure. The observed difference in viability of the young at birth is believed to be due to the exposure of the male parent to irradiation prior to mating.

The average number of young born was 7.7 and 6.4, respectively, in the control and test groups (Table 2). The over-all reduction in fertility is further emphasized in the average number born alive per mating (Table 2).

Since it has been suggested that genetic damage would more likely be apparent in offspring conceived immediately after irradiation of the parent than in later births (15), the data on fetal mortality (Table 1) and numbers of young born (Table 2) for all females mated to irradiated males were tabulated so that any differences in fertility, zero to 35 days and 36 to 108 days post-treatment, could be studied. The data fail to show any difference; consequently, the data for the two periods were pooled for analysis. Admittedly the two intervals were somewhat arbitrarily selected, but it has been reported that in rabbits, after ligation of the epididymis, the sperm contained in the epididymis were in no case capable of effecting fertilization longer than 38 days (16).

No information regarding the viability or growth of the young which were born alive was obtained from this study. It is conceivable that not all the defective offspring died before or at the time of birth. A study of the growth rates and other criteria of viability in such young would seem desirable.

The pooled fertility data for all treated males indicate that deleterious effects on the prenatal viability of the offspring occur when the male has been exposed to the relatively low levels of radiation (100, 200, or 300 r) used in this study. In view of this, extreme caution should be exercised in the voluntary exposure of humans to ionizing radiation approaching this order of magnitude until further experimental evidence is available.

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Manuscript received January 18, 1952.

Electron Microscopy of Isolated Chromosomes¹

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Electron microscopical studies of isolated chromosomes have been made by a number of investigators (1-3). In the present work, the organization of chromosomes isolated from turkey and chicken erythrocytes and from calf thymus by the methods of Mirsky and Ris (4, 5) has been studied in the electron microscope, which was used in conjunction with certain chemical and enzyme treatments. Special emphasis has been placed on the use of an electron staining procedure for desoxyribose nucleic acid, which has been described by Bretschneider (6).

Since the procedure used for the isolation of fowl erythrocyte chromosomes has been slightly modified from that described by Mirsky and Ris (4), it is outlined briefly here. Oxalated turkey or chicken blood was frozen at -40°C immediately upon withdrawal from the fowl. The thawed blood was then used for the isolation of erythrocyte nuclei, which were washed with 0.14 M NaCl until practically colorless. Four successive 5-min treatments of dilute suspensions of the nuclei in the Waring blender produced a chromosome suspension almost free of unbroken nuclei (microscopic examination of aceto-orcein stained specimens). The chromosomes, washed twice by dispersion in saline in the blender, were stored in plastic tubes in a cold room at 4°C . The use of blood that had been frozen prior to use for isolation of nuclei was found to greatly facilitate their rupture in the subsequent Waring blender treatment.

The staining procedure described by Bretschneider (6) for the demonstration of desoxyribose nucleic acid in bull sperm has been applied to whole chromosomes from fowl erythrocytes and from calf thymus. "Residual chromosomes" were prepared from fowl erythrocyte chromosomes by 1 M NaCl extraction (2), in order to remove the outer nucleohistone layer, and were similarly stained. The staining procedure applied to concentrated suspensions of chromosome preparations in saline comprised mercuric chloride fixation,

¹This investigation was supported by a research grant from the National Institutes of Health, U. S. Public Health Service, administered by The Ohio State University Research Foundation.

²The authors gratefully acknowledge the assistance of Emil S. Palik and Richard Smith in some of the experimental work reported.

washing with alcoholic iodine solution, treatment with alcoholic dimedon solution followed by washing with a water-ethanol sequence of 70-0% ethanol, hydrolysis with HCl, silver nitrate staining, and pepsin digestion.

Chromosome preparations, mounted on Formvar films, were examined in an RCA Model EMU electron microscope. Certain specimens were shadowed with chromium by standard techniques. Aceto-orcein staining and the application to the mounted specimens of electron stains such as 0.1% phosphotungstic acid, saturated molybdic acid solution, and 2% osmic acid were also carried out.

Whole chromosomes from fowl erythrocytes, when stained with aceto-orcein or with the electron stains just mentioned, were found to be moderately kinked strands with diameters ranging from 0.06 to 0.5 μ and lengths from 3 to 8 μ . The light micrographs of Mirsky and Ris (4) show a range of diameters from 0.3 to 0.8 μ and lengths from 3 to 5 μ . There was no definite evidence for chromomeres or multiple strands within the whole chromosomes when studied by the above techniques.

"Residual chromosomes" from turkey erythrocytes when shadowed with chromium, with and without chromic acid fixation, gave structures similar to those reported by Denues (2). The reduction in diameter caused by 1 M NaCl treatment is notable, and the "residual chromosomes" were thus found to be kinked strands with an average diameter of about 0.05 μ . There was no evidence for the association of two or more strands in most of the structures observed.

Typical results of the silver-staining procedure of Bretschneider (6) applied to whole chromosomes from fowl erythrocytes and from calf thymus are illustrated in Fig. 1. In Fig. 1 A it can be seen that material of high electron scattering power, probably silver, is uniformly distributed along a single chromosome strand. Chemical analysis of the strands indicated 7.17% of silver present. Chromium shadowing indicated that the strands were not flat ribbons but had cross sections that were approximately circular. The dark projections protruding from the strand were present before exposure to the electron beam, since it was observed that the projections cast shadows. Exposure of the strands observed at low electron beam intensities (Fig. 1 A) to beams of higher intensity caused staining material to leave certain regions either by migration or evaporation and produced the structure seen in Fig. 1 B. The principal feature of chromosome structure revealed by this figure is the long thin cylindrical casing which will be called a tubule. Completely identical structures were obtained by the Bretschneider staining procedure, regardless of whether the starting material was whole chromosomes

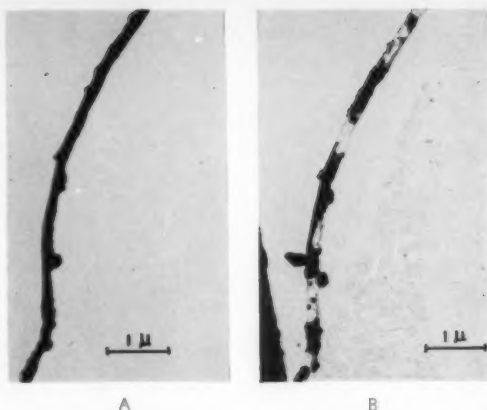


FIG. 1. Calf thymus chromosome after Bretschneider staining procedure: A, observation at low beam intensity; B, after exposure to higher beam intensity.

from fowl erythrocytes and from calf thymus or "residual chromosomes" from turkey erythrocytes. This tubule is the key structural element of the chromosomes studied in this investigation.

As a control, sheep erythrocytes were carried through the same isolation and staining techniques as fowl erythrocytes. Although occasional strandlike structures were seen in the specimens stained with aceto-orcein, no strands were seen after staining with silver in the usual manner.

In a study of the various steps in the Bretschneider staining procedure applied to whole chromosomes it was found that, until the digestion with pepsin in 0.1 N HCl, the major part of the desoxyribose nucleic acid, and some of the histone of the outer sheath, are still attached to the central tubule, and the great reduction in diameter occurs when these constituents are removed. The complete absence of ribose nucleic acid in the tubule was shown by chemical analysis.

A more detailed account of the present work will be published elsewhere. Studies carried out on chromosomes in smears from *Drosophila melanogaster* and *Rhoeo discolor* are reported in a separate paper.

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Comments and Communications

Geology, Soil Mechanics, and Botany

THE youthful science of soil mechanics properly belongs with the other earth sciences in the geology family, for it deals with the physical properties of the surficial mantle of the earth and the explanation of geological phenomena, but we geologists have neglected our infant, and it has been kidnapped by the engineers. While working in Alaska on frozen ground problems in 1935, I tried, unsuccessfully, to persuade the U. S. Geological Survey and one of the mining companies to start a continuing research project on problems associated with the perennially frozen ground. World War II has emphasized the importance of these problems, and in recent years the Navy, the Army, the U. S. Geological Survey, and other organizations have sponsored much research in this field; but most, if not all, the enthusiastic young scientists who have gone into the work have been handicapped by lack of training in soil mechanics. The illustration given below is typical of many recent publications.

In *Geological Survey Bulletin 974-C, Frost Action and Vegetation Patterns on Seward Peninsula, Alaska* (1), a botanist and a geologist have collaborated to give an excellent description of tundra vegetation—and more cooperation of this kind is needed—but the explanations given for the development of cotton grass (*Eriophorum*) tussocks, peat rings, and other features do not conform with our knowledge of the mechanics of frost action.

A tussock, called "niggerhead" in Alaska, consists of a small earth mound topped by a more or less spherical mass of living and dead plant parts, the whole having a height ranging from a few inches to 1½ feet. Tussocks are quite stiff and, when closely spaced, make travel across the tundra very laborious.

The authors state (p. 54) that soil movement results "from frost heaving (vertical expansion), frost thrusting (horizontal expansion) . . . and subsidence during thawing," and (p. 76) they explain the development of the tussock earth mounds as follows:

During the autumn freezing cycle, the sides of the tussocks and the *Sphagnum* mosses and mineral soil surrounding the tussocks freeze more rapidly than the matted culm bases. . . . Lower moisture content and better insulation due to the presence of dead air spaces account for the slow rate of freezing of the culms and roots. The freezing mineral soil between the tussocks expands and moves laterally into the thawed zone beneath the tussock, forcing it upward (fig. 28G). Repeated cycles of frost thrusting from the intertussock areas raise a mound of mineral soil beneath the tussock and force the proximal portions of the roots vertically out of the soil.

This explanation has also been given for tussocks in Massachusetts marshes (2).

Before and during freezing, the pressure at any point below the surface is determined by the weight

of the overlying soil, except locally where there is bridging. Therefore, at a depth of a foot or so under a tussock mound, the pressure is greater than at the same level under the surrounding area, and, if the soil were sufficiently fluid to transmit hydraulic pressure, the tussock should sink and the surrounding area be pushed up instead of the reverse. In late August on the Seward Peninsula, when the ground had thawed to a depth of about 1½ feet, a tussock supported the weight of the writer without perceptible settling.

The soil of Seward Peninsula is mostly silt, and when fine-grained soils freeze slowly, water segregates to form layers or lenses of ice consisting of prismatic crystals oriented normal to the surface. The crystals exert pressure in the direction of growth, which is normal to the cooling surface. The upward heaving of soil is not due to change in volume, for similar results have been obtained experimentally with liquids that freeze with decrease in volume. The pressure developed by the growing crystals is determined by the resistance to growth—that is, the weight of the overlying soil. A simple experiment (3) has been used to prove that the ice crystals develop a linear, instead of a volumetric, pressure. Fill some glass test tubes with clay saturated with water. Expose half of them to cooling from all directions and they will break, because ice crystals will grow radially inward, exerting pressure against the walls of the tubes. Insulate the other tubes, leaving only the upper surface of the clay exposed to cooling, and the tubes will not break. Ice layers will form in the upper part of the clay, raising the surface, and shrinkage cracks will form in the lower part because of withdrawal of water.

If tussocks owe their height in part to frost heaving, the explanation is probably the same as for the upward migration of stones in soil (4), the heaving of fence posts, and similar phenomena. As soil freezes and growing ice crystals lift the surface, the frozen layer may grip a fence post, or other object, and drag it upward, leaving a void at the base. When thawing occurs, the surface soil returns to its original position but the post does not, for it is held up by friction and by partial filling of the void with soil fallen from the sides or washed in by meltwater.

In areas of severe frost-heaving, farmers in early spring give fence posts a few taps with a hammer to drive them down. If they wait several months until the voids are largely filled, the hammer blows are less effective. In Alaska telephone wires are often strung on tripods, as poles are overturned by heaving unless well anchored in the perennially frozen subsoil. Winter wheat is occasionally killed by heaving and exposure of roots, seedling pines have taproots broken, and other forms of vegetation are damaged or killed by frost heaving.

If geology students planning to study problems involving frost action could take a well-designed labora-

tory course in soil mechanics, we would have fewer papers in which geological phenomena are attributed to horizontal thrusting or expansion in volume; and, also, they might better appreciate the value of experimental, as well as observational, evidence in the solution of geological problems.

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Use of Silicones in Preparation of Samples for Radioactivity Measurement

IN THE preparation of counting samples by evaporation of aliquots of solutions, difficulty is often encountered in obtaining uniform size and position of the final sample spot, because many solutions tend to creep and to spread irregularly on the planchette while being dried. Silicones may be used in two ways to good advantage in the preparation of such samples.

1) For mounting samples on flat metal planchettes, a small amount of silicone grease¹ is rubbed on the surface of the planchette, and all excess is wiped off with a cleansing tissue. The planchette is placed on a motor-driven turntable operating at low speed (10–20 rpm), and the sample is applied to the silicone-treated surface from a micropipette. With ordinary care in

¹ We have found Dow-Corning stopcock grease best for this purpose.

application, up to 200 μ l of solution may be applied to form a "lens" no larger than 0.5" in diameter. The planchette can then be removed from the turntable and dried under a heat lamp in the ordinary fashion; very little or no extension of the sample area occurs during drying.

2) For mounting samples on microscope cover glasses, the cleaned cover glass is placed on a motor-driven turntable, which is set in motion. A capillary, containing silicone fluid (Dow-Corning #DC804, diluted with an equal volume of ether) or a solution of Canada balsam in xylene, is lowered so as to deposit a circle of the fluid on the surface of the glass; the capillary is held in a fixture consisting of a stopcock held on a ring stand by a clamp so that reproducible circles can be made. The cover glass thus prepared is allowed to dry, the sample is then spread on the area inside the circle and is dried in the usual fashion. The same technique can also be used with flat metal planchettes. The circles made with silicone-ether mixture dry much more rapidly than do those made with balsam.

It has been the writers' experience that the use of silicones as described here simplifies the preparation of counting samples of uniform area and position. Replicate samples thus prepared are almost always found to give counting rates checking each other within the statistical accuracy to which the counting is done.

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- July 14-17. International Seaweed Symposium. Edinburgh University, Edinburgh.
- July 14-19. International Congress of Physical Medicine. London.
- July 15-18. International Society of Geographic Pathology. Liège, Belgium.
- July 16-18. Institute of the Aeronautical Sciences (Annual). Los Angeles.
- July 21-23. International Society of Soil Science. University College, Dublin.
- July 21-26. Industrial Microbiology Institute. Purdue University, Lafayette, Ind.
- July 21-27. International Congress of Biochemistry. Paris.
- July 25-Aug. 1. IUBS, Colloque sur le Bacteriophage. Paris.
- July 26-30. Conference on Research in Race Relations. University of Chicago.
- July 26-31. Conference on American Foreign Policy (Annual). Colgate University, Hamilton, N. Y.
- Aug. 11-21. Union Radio-Scientifique Internationale. Sydney, Australia.
- Aug. 12-15. Poultry Science Association. University of Connecticut, Storrs.
- Aug. 12-16. Photographic Society of America (Annual). Hotel New Yorker, New York.
- Aug. 12-16. Plant Science Seminar (Annual). Philadelphia.
- Aug. 15-22. International Conference of Agricultural Economists. East Lansing, Mich.
- Aug. 17-23. American Pharmaceutical Association. Hotel Bellevue-Stratford, Philadelphia.
- Aug. 17-23. International Grassland Congress. Pennsylvania State College, State College.
- Aug. 19-22. American Institute of Electrical Engineers (Pacific General). Hotel Westward Ho, Phoenix, Ariz.
- Aug. 20-27. Australian and New Zealand Association for the Advancement of Science (Annual). Sydney.
- Aug. 20-28. International Congress on Theoretical and Applied Mechanics. Istanbul, Turkey.
- Aug. 22-30. Australasian Medical Congress. Melbourne.
- Aug. 24-27. International Union against Tuberculosis. Rio de Janeiro.
- Aug. 25-29. Oak Ridge Summer Symposium on "The Role of Atomic Energy in Agricultural Research." Oak Ridge, Tenn.

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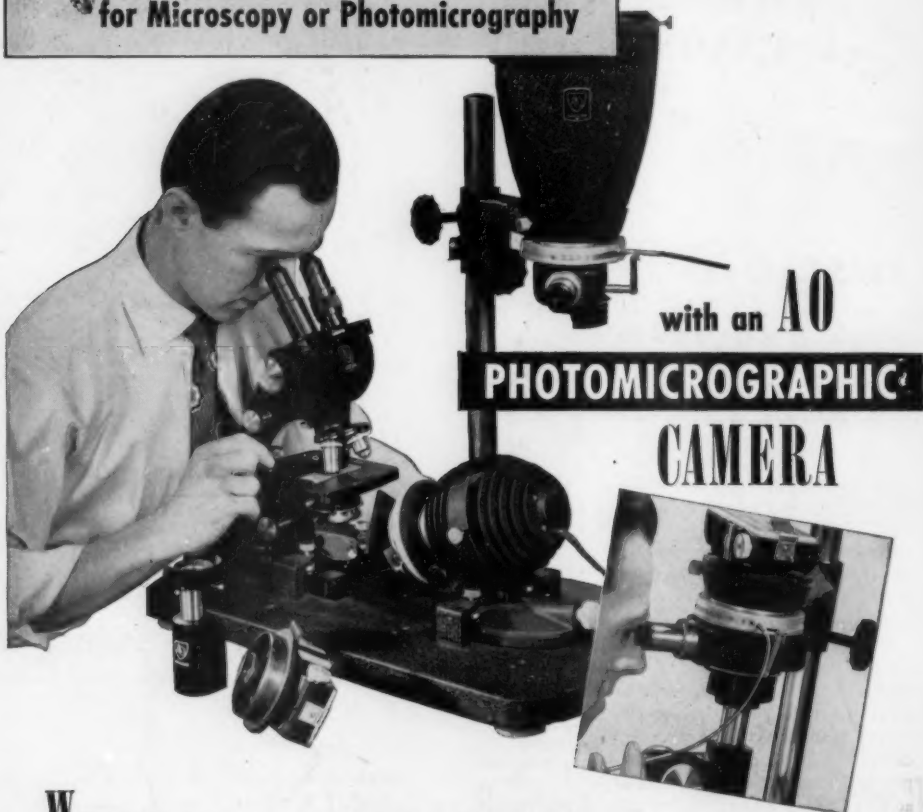
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